MEMORANDUM

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DIVISION OF WATER PROGRAMS COORDINATION
OFFICE OF SPILL RESPONSE AND REMEDIATION

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SUBJECT: GUIDANCE MEMORANDUM 00-2014
Quality Assurance Project Plan for the State Lead Program

TO: Regional Directors

FROM: Larry G. Lawson, P.E.

DATE: September 13, 2000

COPIES: Regional Storage Tank Program Managers, J. Andrew Hagelin, Fred Cunningham, Dave Chance, James Barnett, John Giese, Gary Du

The DEQ Storage Tank Program, as part of its grant commitment to EPA has developed and implemented a Quality Management Plan (QMP) to ensure that data collected by this program is of sufficient and known quality to support the decision making processes. The QMP identified two primary areas: (1) the Alternate Water Supply (AWS) Program, and (2) the State Lead Program, where Storage Tank Program Staff or Contractors hired by the Storage Tank Program collect environmental data. In accordance with the QMP, a Quality Assurance Project Plan for the State Lead Program was developed to provide staff and contractors hired by DEQ with quality assurance procedures for the State Lead Program.

A collaborative process was used to develop the Quality Assurance Project Plan (QAPP) for the State Lead Program. The QAPP for the State Lead Program was developed by the Storage Tank Quality Assurance Manager and the State Lead Program Manager in OSRR. A draft of this document was then sent to the DEQ Quality Assurance Officer and each of the regional Storage Tank Program Managers for comment. Comments from the Quality Assurance Officer and Regional staff and managers were then incorporated into the QAPP. This QAPP was then placed in the request for bid package and provided to all contractors who expressed an interest in bidding on the State Lead Contract. The contractors were required, as part of the bid evaluation procedure, to provide internal sampling and quality assurance procedures to be incorporated into the State Lead QAPP.

The QAPP for the State Lead Program will be placed on the DEQ Web Page. If you have any questions about the QAPP, please contact James Barnett.

DISCLAIMER

This document provides procedural guidance to the DEQ Storage Tank Program staff and contractors performing work for the State Lead Program. This document is for guidance only. It does not establish or affect legal rights or obligations. It does not establish a binding norm and is not finally determinative of the issues addressed. Agency decisions in any particular case will be made by applying the State Water Control Law and the implementation regulations on the basis of the site-specific facts.

STORAGE TANK PROGRAM
QUALITY ASSURANCE PROJECT PLAN
STATE LEAD PROGRAM

(September 7, 2000)

Document # 00-2014

Quality Assurance Project Plan
State Lead Program

TABLES

APPENDICES

QUALITY ASSURANCE PROJECT PLAN
State Lead Program

1 INTRODUCTION

The Virginia Department of Environmental Quality (DEQ) Storage Tank Program is responsible for ensuring that human health and the environment are protected from releases of petroleum and regulated substances from storage tanks. When a release occurs from a storage tank, the DEQ will direct the responsible person (RP) to initiate release response and corrective action. If DEQ cannot find the RP or the RP is unwilling or unable to conduct the necessary work, the DEQ can investigate and clean up the release under the State Lead Program.

The purpose of this quality assurance project plan is to ensure that procedures used and data collected by the State Lead Contractor(s) are of sufficient quality to support decisions. This Quality Assurance Project Plan is developed jointly by the DEQ Storage Tank Program and the State Lead Contractor(s). Standard sample collection procedures used by the State Lead Contractor are included in this document. These standard sample collection procedures may be modified as agreed to by the Regional State Lead Project Manager and the State Lead Contractor to meet site-specific data quality objectives.

2 PROJECT DESCRIPTION AND MANAGEMENT

The DEQ Storage Tank Program is responsible for ensuring that human health and the environment are protected following releases of petroleum into the environment. When petroleum is released from a storage tank, the owner or operator of that tank and/or the spiller (Article 11 cases) is responsible for stopping the release, characterizing the site, and cleaning up the release. Investigations and cleanups conducted by the responsible person (RP) are referred to as "RP Lead" cleanups by the Storage Tank Program.

In a relatively small percentage of the petroleum releases, DEQ investigates the release and finds that the RP no longer exists or is unwilling or unable to conduct the cleanup. In these instances, the DEQ Storage Tank Program may place the site in the State Lead program. Once a site is placed in the State Lead Program, the regional staff will evaluate the site and compare the need for corrective action at this site with the need for corrective action at other State Lead sites during a particular fiscal year. Once the regional staff determines that the State Lead site is appropriately prioritized and ranks for inclusion in a fiscal year budget, the Regional Office will initiate site clean-up activities.

2.1 Project Responsibilities

When a site is placed in the State Lead program, DEQ, Storage Tank Program staff and managers must evaluate the site and rank that site relative to all other state lead sites in that region for a particular fiscal year. Once the region initiates clean up activities at a State Lead site, all persons involved with the State Lead program are responsible, either directly or indirectly, for the quality of data generated as part of this program and for the decisions that are made based upon the data that is collected. Sections 2.1.1 through 2.1.9 describe the roles and responsibilities of DEQ staff, managers, and the State Lead contractor(s). An organizational chart illustrating the lines of formal and functional communication within the State Lead Program is included in Appendix A.

2.1.1 Regional Case Manager

Petroleum releases must be reported to the appropriate DEQ Regional Office. Upon receiving a report of a petroleum contamination, the Regional Storage Tank Program Manager will direct one of the Regional Case Managers to investigate the report. The individual Case Manager to whom the case is assigned is responsible for investigating the report and determining if a petroleum release has occurred. If the Case Manager determines that a release has occurred, the Case Manager will determine the RP.

The Case Manager is also responsible for identifying cases that are eligible for the State Lead program. In general, petroleum contamination from USTs, ASTs, or unknown sources may be eligible for the State Lead program if:

1. The owner or operator is unknown;

2. The owner or operator is financially incapable of undertaking release response and corrective action; or
3. The owner or operator unwilling to take appropriate actions and immediate corrective action is needed at the site.

A State Lead Program eligibility flowchart is included as Appendix B. Additional guidance for determining whether a site is eligible for the State Lead Program may be found in the State Lead Program Manual.

NOTE: When a release from a regulated UST is reported to the DEQ, the Storage Tank Program will attempt to determine the person responsible for the release. In most instances, a RP is identified and release investigation, response, and/or remediation will proceed as a "RP lead site." The Case Manager within the context of this document is the DEQ Regional Staff member who is responsible for investigating a suspected or confirmed release while that release is being administered as a RP lead cleanup.

2.1.2 Regional State Lead Project Manager

Once a State Lead site has been prioritized and the regional staff determines that the fiscal year budget allocation will allow for release investigation, response, and corrective action activities at the site, the DEQ regional staff may initiate these activities by contacting the State Lead Contractor and requesting the preparation of an Activity Authorization Package for the site. The Regional State Lead Project Manager for the particular site and the State Lead Contractor will work together to determine the actions needed to meet remediation goals for the site. The Contractor will place the activities needed to complete the scope of work on an Activity Authorization Form (AAF) and submit this form to the Regional State Lead Project Manager for approval.

After the Regional State Lead Project Manager approves the first AAF for the site, the Regional State Lead Project Manager must notify (or direct the Contractor to notify) the property owner(s) and obtain the site access needed to conduct the agreed upon scope of work. Once site access is obtained, site work may be initiated on a schedule agreed to by the Regional State Lead Project Manager and the Contractor.

Once a phase or sub-phase of work is completed at a State Lead site, the Contractor will usually provide a written report to the Regional Office summarizing the work performed and providing information needed to determine the future course of action at the site.

NOTE: The Regional State Lead Project Manager is the DEQ Regional Staff member tasked with managing a release investigation, response, and/or corrective action at a Lead Site. The Regional State Lead Project Manager will review and approve work to be performed at a State Lead site and perform all other case management functions related to that State Lead case. Regions may have one Regional State Lead Project Manager who manages all State Lead Projects within that region or there may be multiple Regional State Lead Project Managers within a particular Regional Office.

2.1.3 State Lead Program Manager

Storage Tank Program staff in both the Regional Offices and OSRR share in the responsibilities for implementing the State Lead Program. Contract management of the State Lead Program is administered by the State Lead Program Manager in OSRR. The State Lead Program Manager also determines State Lead budget allocations for each region.

Standard operating procedures for the State Lead Program are developed jointly by the Storage Tank Program personnel in OSRR and the Regional Offices. The State Lead Program Manager is responsible for coordinating the development of standard procedures for the State Lead Program and modifying existing procedures as needed. The State Lead Program Manager along with other Central Office Staff will assist the Regional State Lead Project Manager as needed with release investigations and the evaluation of corrective action plans for impacted sites.

Quality assurance documents for the State Lead Program are developed jointly by Storage Tank Program Staff from OSRR and the Regional Offices as well as the State Lead Contractor(s). The State Lead Program Manager will assist the Storage Tank Quality Assurance Manager with the development of quality assurance documents and procedures for the State Lead Program. The State Lead Program Manager also will assist the Storage Tank Program Quality Assurance Manager with audits and evaluations of the Quality Management system used within the State Lead Program.

2.1.4 OSRR Staff and Management

Technical guidance and procedures within the DEQ Ground Water Program are developed jointly by OSRR staff/management and regional staff/management. Once a procedure is adopted by OSRR and the regions, OSRR staff and management provide a written copy of the guidance or procedure to OSRR and Regional staff.

OSRR staff and management are also responsible for developing the quality assurance documents that are needed within the Storage Tank Program. As with other technical documents, OSRR staff must incorporate comments from other Central and Regional Office staff into the Quality Assurance documents. OSRR staff must update and revise quality assurance documents as needed.

2.1.5 Financial Responsibility Manager

During the course of determining the RP for a release, Regional Case Managers may encounter unusual circumstances and documentation that can affect the RP determination process. The Financial Responsibility Manager in OSRR will assist Case Managers with RP determinations as needed. Inability to pay for the necessary corrective actions is a claim that is frequently made by responsible persons. If a RP claims to be financially incapable of proceeding with corrective action, even after considering reimbursement from the Fund, regional staff should inform the Financial Programs Manager in OSRR so that an inability to pay application and additional guidance may be provided to the RP. Information that regional staff must provide to the Financial Programs Manager include:

1. responsible person name;
2. responsible person address;
3. responsible person telephone number(s);
4. pollution complaint number;
5. site name;
6. number and type of occurrences;
7. release report date;
8. identification of RP's type of business entity:
    A. individual/sole proprietorship;
    B. bankrupt;
    C. corporation;
    D. partnership;
    E. estate;
    F. non profit organization; or
    G. other (limited liability company, government entity, etc.).
9. filing deadline for the next report required for the case.
10. whether a responsible person filed a tax return the previous year (this only applies to individuals).

Upon receiving this information, the Financial Programs Manager will contact the responsible person and send the necessary forms and instructions to that person. The Financial Programs Manager will also copy the Regional Office on correspondence with the RP.

After receipt of the completed claim form and other financial information, the Financial Programs Manager will perform the Ability to Pay analysis. If the RP has been determined to be unable to pay but the site has not yet been referred for state lead, the Financial Programs Manager will copy the Regional Office on the determination letter sent to the responsible person. In addition, the Financial Programs Manager will send a memorandum to the Regional Storage Tank Program Manager requesting that the site be referred to state lead. If the RP is determined to be able to pay, the Financial Programs Manager will copy the Regional Office on the Ability to Pay determination letter sent to the RP.

2.1.6 Regional Storage Tank Program Manager

The Regional Storage Tank Program Manager is responsible for overseeing all activities performed by Storage Tank Program staff in that region. The Regional Storage Tank Program Manager assigns release reports to individual Case Managers and ensures that these releases, suspected or confirmed, are investigated in accordance with DEQ procedures.

The Regional Storage Tank Program Manager and/or a person designated by the Regional Storage Tank Program Manager is responsible for assisting OSRR with the development, review, and revision of program procedures. The Regional Storage Tank Program Manager is also responsible for ensuring that all staff members performing work on a project are familiar with Storage Tank Program standard procedures.

2.1.7 DEQ State Lead Contractor

The State Lead Contractor performing work for the Storage Tank Program is an integral component of the Quality Assurance process. The State Lead Contractor may, depending upon the scope of work for the site, close USTs, investigate petroleum contamination to determine the source of that contamination, characterize a site following a release, and implement corrective actions to clean up a release.

When a DEQ Regional Office contacts the State Lead Contractor about performing work at a site, the State Lead Contractor must work with the Regional State Lead Project Manager to determine an appropriate scope of work for the site. The State Lead Contractor will prepare and submit a State Lead AAF to the Region for the scope of work to be performed for the site. After the State Lead AAF is approved, the contractor will initiate the specified scope of work.

The State Lead contractor is the primary entity collecting data for State Lead site. DEQ relies on the data collected by the State Lead Contractor to determine the actions that are necessary to protect human health and the environment at a State Lead site. The State Lead Contractor is responsible for ensuring that staff performing field work and collecting environmental data are trained to collect that data and are familiar with standard sample collection procedures.

The Quality Assurance Project Plan for the State Lead Program incorporates elements from both the DEQ and the State Lead Contractors. Each State Lead Contractor is responsible for providing standard sampling and document management procedures to DEQ as a condition of this contract. These procedures are incorporated into this Quality Assurance Project Plan. If existing sampling, document, or other quality management procedures used by the State Lead Contractor are not expected meet data quality objectives for a site, the State Lead Contractor must contact the Regional State Lead Project Manager. The State Lead Contractor and the Regional State Lead Project Manager must then evaluate the identified problem, initiate the agreed upon corrective measures to address the identified problem, and document these activities in the Regional case file.

Note: The State Lead Program Manager and the Storage Tank Program Quality Assurance Manager will assist the State Lead Contractor and Regional State Lead Project Manager with evaluating and selecting case specific corrective measures if assistance is requested.

2.1.8 Storage Tank Program Quality Assurance Manager

The Quality Assurance Manager for the Storage Tank Program is responsible for developing, maintaining, and updating all quality assurance documents for the State Lead Program. This person also must:

1. develop and distribute quality assurance documents, policies, and procedures to all persons working in the State Lead Program;
2. assess the effectiveness of quality assurance procedures for the State Lead Program;
3. record the results of Data Quality Audits, Technical Assessments, and other assessments related to quality assurance within the State Lead Program;
4. report the results of Data Quality Audits, Technical Assessments, and other assessments related to quality assurance within the State Lead Program to OSRR Management, the State Lead Program Manager, the Regional Storage Tank Program Manager and Regional State Lead Project Managers.
5. work with OSRR and Regional Storage Tank personnel to identify deficiencies in the quality assurance process and determine the actions needed to correct those deficiencies; and
6. identify training needs and report those needs to the Director of OSRR and the Regional Storage Tank Program Managers.

The Storage Tank Program Quality Assurance Manager also may assist the State Lead Manager with the development, review, and revision of State Lead procedures. The Storage Tank Program Quality Assurance Manager is also available to assist the Regional State Lead Project Managers as needed.

2.1.9 DEQ Quality Assurance Officer

The DEQ Quality Assurance Officer will review quality assurance documents developed by the Storage Tank Program and assist the Storage Tank Quality Assurance Manager with auditing and assessing QA/QC procedures used by this program. The DEQ Quality Assurance Officer is outside of the Storage Tank Program chain-of-command and is expected to add a level of objectivity to QA/QC reviews and audits.

The DEQ Quality Assurance Officer reviewed and approved the Quality Assurance Project Plan for the State Lead Program before the plan was completed. The Quality Assurance Officer will also be involved in the review of all major revisions of this Project Plan.

Technical System Audits and Management System Reviews of the State Lead Project Plan will be coordinated by the Storage Tank Program Quality Assurance Manager. The DEQ Quality Assurance

Officer will assist with Technical System Audits and Management System Reviews.

2.2 Data Quality Objectives

Data quality objectives are primarily based upon the decisions that the data must support. Once a release has been reported to or discovered by DEQ, the next step in the release response and corrective action process usually involves determining the person responsible for cleaning up the release. Information collected in this area is critical from a resource management perspective. The DEQ seeks to have the person responsible for cleaning up the release manage the actual clean-up process. This allows DEQ staff and the State Lead Contractor to spend additional resources in areas where those resources are required.

Work performed by the State Lead Contractor to characterize and clean-up releases may vary greatly from one site to the next or from one corrective action phase to the next phase at a particular site. The data quality objectives for data collected as part of the State Lead Program vary depending upon the decisions that must be made at the site during a particular phase of work. Data that is collected to characterize a release must provide information about the severity and extent of contamination at the site and be capable of enabling the State Lead Contractor and DEQ staff to evaluate risks to receptors and remedial alternatives at the site. Data that is collected after a remediation system is installed may be used to evaluate the effectiveness of the remediation system. In all instances, the DEQ Regional State Lead Project Manager and the State Lead Contractor are expected to decide upon a scope of work and data quality objectives for a particular phase of work at a site before that scope of work is initiated.

2.3 Training Requirements

The State Lead Program must have data of a sufficient and known quality in order for DEQ to protect human health and the environment. Obtaining data of such quality requires that the persons collecting the data use procedures that will ensure the integrity of that data. Persons collecting data for the State Lead Contractor must be familiar with and use established sample collection procedures in order to ensure that the data collected meet the Data Quality Objectives for the phase of work at a particular State Lead site.

2.3.1 Training Requirements - DEQ Regional State Lead Project Managers

Sample and data collection for the State Lead Program are performed by the State Lead Contractor. The DEQ Regional State Lead Project Manager's role in the Quality Assurance process is predominantly related to determining the data quality objectives for the site or the specific phase of work that will be performed for the site, determining the number and type(s) of samples and other data that are needed to meet the data quality objectives, evaluate the data received from the State Lead Contractor, and determine the future course of action for the site.

Given these responsibilities, DEQ Regional State Lead Project Managers must be familiar with current investigative and corrective action techniques. They must also understand their roles in the State Lead process and current Storage Tank Program procedures. Staff must also be familiar with the standard data collection procedures used by the State Lead Contractor and must be able to work with the State Lead contractor to adjust procedures as needed to meet site specific data quality objectives.

2.3.2 Training Requirements - State Lead Contractor(s)

The State Lead Contractor is responsible for collecting the samples and other types of data at most State Lead sites. Samples and other field data collected for the State Lead Program must meet the data quality objectives specified by the Regional State Lead Project Manager. The Regional State Lead Project Manager and the Contractor are expected to discuss these objectives and determine the scope of work needed to meet these objectives. The DEQ expects the State Lead Contractor to have standard sample collection procedures and field personnel collecting samples and other data for the State Lead Contractor are expected to be familiar with these standard procedures. If the State Lead Contractor and the Regional State Lead Project Manager believe that the standard procedures should be modified for a particular site or phase of work at that site, the State Lead Contractor must ensure that persons collecting the data are aware of these changes.

Depending upon the scope of work, data collection at the site may involve the use of hand-held or portable field instruments. Field personnel using these instruments are expected to be trained in their use and follow the manufacturer's instructions. The State Lead Contractor must provide DEQ with a list of field test equipment used and instructions for operating that equipment. Field equipment requiring calibration must be calibrated in accordance with instructions provided by the manufacturer.

During site visits, persons collecting data in the field are expected to record information about the site. They must be informed as to the types of information that must be recorded and the disposition of that information.

2.4 Documentation Requirements

2.4.1 Field Notes

During most site visits, the State Lead Contractor will be collecting data about the site. The person visiting the site is responsible for recording information about the site and any samples collected. This person is then expected to record information collected from the site in a bound field notebook. All entries will be recorded in indelible ink. Each page of field notes collected for a site must contain the pollution complaint number for the case and be initialed by the investigator and dated. Copies of all field notes must be placed in the appropriate case file in the State Lead Contractor's office.

2.4.2 Chain-of-Custody

Once a sample is collected, precautions must be taken to preserve the sample's chemical and physical integrity during transport to the lab and storage prior to analysis. The State Lead contractor is responsible for documenting that the integrity of the samples has been maintained during transport to and storage at the lab.

The person collecting samples in the field is responsible for custody of those samples until those samples are placed in a cooler (or other appropriate shipping container) along with the necessary documentation and released directly to a courier or the laboratory. From this point forward, the laboratory is responsible for custody of the samples.

When the State Lead Contractor sends samples to a laboratory, the following procedures should be used to document custody of the sample:

1. A Chain-of-Custody form must be completed for all samples collected.
2. The Chain-of-Custody form must be signed by each individual who had possession of the samples.
3. If samples must be placed in multiple coolers, a separate Chain-of-Custody form must be used for the samples in each cooler.
4. If the samples will be sent to the lab via a courier (i.e., commercial carrier)
   - A. The original of the Chain-of-Custody form and one copy should be placed in a watertight plastic bag inside the cooler (or other appropriate shipping container). It is recommended that this plastic bag then be taped to the lid or top of the shipping container.
   - B. One copy of the Chain-of-Custody form must be retained by the person collecting the samples and subsequently, placed in the appropriate case file.
   - C. The waybill will serve as an extension of the Chain-of-Custody record between the final field custodian and receipt of the sample(s) in the lab.
   - D. The sender's copy of the waybill should be stapled to and placed in the appropriate case file with the sampler's copy of the Chain-of-Custody form.
   - E. The waybill tracking number should be entered on the Chain-of-Custody form and in the field log book.
5. If the samples are transported directly to the lab by the State Lead Contractor:
   - A. When samples are transported directly to the lab by the person who collected the samples, that person should initial the "Relinquished by" block on the form upon arrival at the lab.
   - B. The person at the lab receiving the samples should then initial the "received by" block on the Chain-of-Custody form.
   - C. When the samples are transported to the lab by someone other than the person collecting the samples, the person who collected the samples must initial the "relinquished by" block on the form and the person who will transport the samples to the lab must initial the "received by" block.
   - D. Upon arrival at the lab, the person transporting the sample(s) will initial the second "relinquished by" block on the Chain-of-Custody form and the person at the lab will

initial the second "received by" block on the form.

NOTE: DEQ staff will not routinely collect analytical data at state lead sites. Staff collecting data at a State Lead site should follow the chain-of-custody guidelines listed in the Quality Assurance Project Plan for the AWS Program.

2.4.3 Analytical Results

Analytical results for samples collected by the State Lead Contractor will be provided to the DEQ Regional State Lead Project Manager in the report or other written deliverable document for that particular phase of work. Analytical results provided to DEQ must be submitted on laboratory letterhead and signed by a person responsible for analyses performed by the lab. The analytical sheet(s) must also list the method used, detection limits, sample dilution (if applicable), the date on which the sample was collected, the date that the sample was extracted (if applicable), and the date on which the sample was analyzed.

3 DATA ACQUISITION

3.1 Sample Collection Process

The State Lead Contractor, as a condition of the State Lead Contract, is required to provide DEQ with standard sample collection procedures that are used by their personnel. These standard sample collection procedures used by the State Lead Contractor are included in this Quality Assurance Project Plan as Appendix D.

The DEQ recognizes that site specific conditions may make it necessary for standard sample collection procedures to be modified in order to meet the data quality objectives for a particular phase of work. When sample collection procedures need to be modified, the State Lead Contractor and the Regional State Lead Project Manager need to determine and agree upon the procedures that will be used to meet the data quality objectives. Once the work is performed, the State Lead Contractor should include a description of the sampling procedures used for that phase of work in the appropriate report or other deliverable document as agreed to by the Regional State Lead Project Manager and the State Lead Contractor.

3.2 Sample Handling Requirements

Proper sample handling is necessary to minimize accidents and ensure sample integrity. Samples collected for the State Lead Program will be labeled immediately after collection, wrapped in a plastic sleeve or other protective covering to prevent breakage of the sample container, and placed on ice. The samples will then be delivered or shipped to a laboratory for analysis.

3.3 Analytical Method Requirements

Samples collected by the State Lead Contractor will be analyzed in accordance with EPA or DEQ Storage Tank Program approved analytical methods.

3.4 Quality Control Requirements

Quality control refers to the series of procedures and activities that are performed to ensure that the data collected meet the established standards. Within the context of the State Lead Program, the primary purpose of quality control is to ensure that the sampling and analytical protocols are properly executed and that errors in the data set are recognized and corrected before DEQ staff make a decision using erroneous data or data that are of insufficient quality to support the required decision.

3.4.1 Blanks

Regional State Lead Project Managers and the State Lead Contractor will determine the need for field, rinsate (equipment), and trip blanks at a site depending upon the scope of work that will be performed at that site. In general, rinsate (equipment) blanks should be included when ground water samples are collected at a site. The purpose of rinsate blanks is to evaluate the effectiveness of decontamination procedures used between the collection of each ground water sample. The number of rinsate blanks that should be collected as part of a particular scope of work should be determined by both the Regional State Lead Project Manager and the State Lead Contractor and based upon the data quality objectives for the scope of work. Rinsate blanks are obtained by running deionized water through all the cleaned surfaces of the sampling equipment that the sample water contacts during the sample collection process. Once collected, rinsate blanks will be placed labeled, placed in the cooler along with the other samples, and sent to the lab for analysis. The method(s) used for analyzing the rinsate blanks should match the method(s) used to analyze other water samples during that particular phase of work.

Field blanks are prepared in the field where ground water samples will be taken by pouring deionized water into the appropriate sample container(s). The purpose of collecting field blanks is to determine if ambient conditions at the site (i.e. automobile exhaust, dust, precipitation, etc.) may bias sample results. Field blanks will not routinely be collected as part of the State Lead Program unless the Regional State Lead Project Manager and the State Lead Contractor believe that the data quality objectives for a particular phase of work warrant this additional information.

Trip blanks are quality control samples that are prepared by the laboratory prior to sample collection activities. These trip blanks are then placed with the other clean (empty) sample containers and accompany the sample containers through the entire sampling and analytical process. The Regional State Lead Project Manager and State Lead Contractor will determine the need for trip blanks on a site and phase specific basis. In general, it is recommended that one trip blank per sampling event be used when ground water samples will be analyzed for volatile constituents.

NOTE: Trip blanks are generally used only when collecting VOC samples.

3.4.2 Laboratory Quality Control Procedures

Samples collected by the State Lead Contractor will be sent to a private lab for analysis. The Storage Tank Program expects these samples to be analyzed by EPA methods or methods approved by the DEQ Storage Tank Program. The analytical methods to be used for a particular phase of work should be specified and pre-approved on the AAF prior to sample collection at the site. Laboratories analyzing samples for the Storage Tank Program must meet the Quality Control requirements specified for the analysis performed.

3.5 Data and Document Management

Storage Tank Program staff in both the Regional Offices and OSRR and the State Lead Contractor all contribute to the base of information collected for a State Lead site and all of these entities, either directly or indirectly are involved in the decisions that are made about the site. A key component of the decision making process is the availability of information. Data and document management consists of the systematic storage and retrieval of information related to the State Lead Program.

3.5.1 Data Management

When a report of a release is received, the regional staff will assign a pollution complaint number (PC#) to the case and establish a file specifically for information related to that case. The Regional Storage Tank Program Manager will then assign the case to one of the Regional State Lead Project Managers who will investigate the release and obtain additional site information such as site location, the source(s) of the contamination, and tank owner's name, address, and phone number. If a tank owner or operator is found, the Regional State Lead Project Manager will then direct the tank owner or operator as the responsible person to characterize and clean-up the release as necessary. If a responsible person is not found, the site may be considered for the State Lead Program.

All data and reports related to investigating, characterizing, and cleaning up a site is placed in the case file for that site in the regional office. The Regional State Lead Project Manager is responsible for reviewing, approving, and processing State Lead AAFs submitted by the State Lead Contractor.

When the scope of work for a particular phase or activity has been completed, the State Lead Contractor will submit a completed State Lead AAF to the Regional State Lead Project Manager for verification. The Regional State Lead Project Manager will verify the work performed and provide this verified AAF to the DEQ Accounting Office. The State Lead Accounting Officer will then review State Lead invoices received and compare those invoices with the approved AAFs.

3.5.2 Document Management

Documents generated as part of the State Lead Program may include, but are not limited to, Initial Abatement Reports, Site Characterization Reports, Corrective Action Plans, periodic monitoring reports, and requests to initiate corrective actions under Interim Authorization. Although analytical data sheets, field notes, and other information collected for a site may be submitted to the DEQ upon request, DEQ expects that this information will usually be contained in a report summarizing the particular scope of work that was completed at the site.

Field notes for most State Lead sites will usually be recorded by either the DEQ regional staff or the State Lead Contractor. Field notes should be recorded in a bound notebook. Copies of field notes taken by regional staff must be placed in the pertinent case file at the Regional Office. Copies of field notes recorded by the State Lead Contractor will be placed in the subsequent report submitted to DEQ for that

scope of work or included with other documents as specified by the Regional State Lead Project Manager.

3.5.2.1 Document Management - DEQ Regional Offices

The DEQ Regional Offices maintain the files of record for all pollution complaints resulting from leaking storage tanks. All information related to release investigation, release response, and/or corrective action for individual State Lead sites is maintained in the Regional Offices.

3.5.2.2 Document Management - OSRR

The files of record for individual State Lead cases are maintained in the Regional Offices. The State Lead Program Manager in OSRR will maintain files related to the State Lead Contract and budget. Information for State Lead cases involving the extension of a public water supply line or other type of alternate water supply project managed by OSRR staff will be maintained by the State Lead Program Manager and/or the AWS Program Manager in OSRR.

3.5.2.3 Document Management - State Lead Contractor(s)

Documents managed by the State Lead Contractor include field notes taken during site visits, laboratory analytical sheets, chain of custody records, and records related to the calibration and maintenance of equipment used to analyze samples. The State Lead Contractor is expected to maintain individual case files for each State Lead case. Field notes, laboratory analytical sheets, chain-of-custody records and other site-specific information must be placed in the appropriate case file. The State Lead Contractor must provide copies of analytical sheets, chain-of-custody records, and field notes to the Regional Office. The Regional State Lead Project Manager also may request equipment calibration and maintenance records and records related to staff training in company-specific standard sample collection procedures.

3.6 Instrument/Equipment Testing, Inspection, Calibration, and Maintenance

The quality of data collected from a site is dependent upon the instruments and other types of equipment that are used to collect the data. DEQ staff, the State Lead Contractor, and laboratories may use instruments that will collect or analyze data for a site. In all cases, instruments and equipment must be inspected, calibrated, and maintained to ensure the integrity of the data provided.

3.6.1 Instruments and Equipment used by the State Lead Contractor

The State Lead Contractor routinely analyzes samples in the field using instrument and/or field test kits. Field instruments that may be used by the State Lead Contractor when characterizing or cleaning up a site may include, but are not limited to, portable flame and photo-ionization detectors, interface probes and/or water level indicators, and instruments for determining standard water quality parameters including pH, conductivity, and temperature. Standard operating procedures for individual instruments and field test kits vary depending upon the kit or instrument used. Unless the Regional State Lead Project Manager and the State Lead Contractor decide that the manufacturer's procedures are not appropriate for a particular phase of work, the State Lead Contractor will use the standard operating procedure that is provided by the manufacturer of the instrument.[3-1] Instruments must be calibrated and maintained in accordance with the manufacturer's instructions. Persons collecting data in the field must specify the date that the instrument was last calibrated in the field notes. Company-specific procedures used by the State Lead Contractors for documenting the appropriate testing, maintenance, inspection, and calibration of field instruments are included in Appendix D.

Depending upon the scope of work for the site, the State Lead Contractor may also use various field test kits with prior approval from the Regional State Lead Project Manager. Samples analyzed by a test kit should be analyzed in accordance with the manufacturer's instructions. Persons collecting samples must be aware that reagents provided in certain test kits may have a listed shelf life. When a test kit is used in the field, the person analyzing the sample must record the type of test kit used and the expiration date for the test kit in the field notebook. Results from test kits that are obtained after the expiration date for the test kit will not be accepted by DEQ.

3.6.2 Instruments and Equipment used by Laboratories

Analytical results for samples collected by the State Lead Contractor or the DEQ staff are critical components in the decision making process at most state lead sites. Calibration of equipment used by private laboratories must be performed in accordance with the QA/QC requirements for the analytical method(s) used to analyze the samples. Equipment calibration at DCLS will be performed in accordance with the DCLS QA/QC procedures manual. Maintenance of equipment used to perform analyses will be performed in accordance with the manufacturer's instructions. The Regional State Lead Project Manager may require the State Lead Contractor to provide QA\QC procedures for commercial laboratories used by that contractor.

[3-1] If the Regional State Lead Project Manager and the State Lead Contractor decide that the manufacturer's standard operating instructions are not appropriate for a particular activity or phase of work, the Regional State Lead Project Manager must ensure that this decision is documented in the case file.

4 PROJECT ASSESSMENT AND CORRECTIVE MEASURES

The process of developing technical procedures for the DEQ Storage Tank Program, either in part or as a whole, is carried out by Storage Tank Program staff and managers within both the regional offices and OSRR. Reviews and assessments of the QA/QC components of the State Lead Program will also be conducted by a group of persons from the Storage Tank Program. In order to obtain input from an individual who is outside of the program, the Storage Tank Program will usually request that the DEQ Quality Assurance Officer assist with reviews and assessments of QA/QC procedures.

When assessments identify procedural changes in the program or quality assurance elements that need to be modified, corrective measures will be developed and implemented. The Quality Assurance Manager for the Storage Tank Program is responsible for coordinating the development of corrective measures. The State Lead Program Manager, selected persons from OSRR, and a group of Regional State Lead Project Managers will assist with developing corrective actions to address the problems identified.

4.1 Management System Review

A management system review is an evaluation of an organization's management practices as they relate to quality assurance. Management system reviews will be performed on the State Lead component of the Storage Tank Program to evaluate the effectiveness of existing management procedures designed to assure data quality, the adequacy of resources and personnel devoted to quality assurance functions, the effectiveness of training and assessments, and the applicability of data quality requirements. Management system reviews will also identify areas where quality assurance improvement is needed and areas where noteworthy accomplishments have been made within the program.

The Quality Assurance Manager for the DEQ Storage Tank Program is responsible for coordinating Management System Reviews. The State Lead Program Manager, Regional State Lead Project Managers from the Regional Offices, and OSRR Management will also participate in evaluating management systems within the AWS Program. The Management System Reviews will examine the following elements of the State Lead Program:

1. The overall effectiveness of the quality management system within the State Lead Program
2. Procedures, criteria, and schedules for conducting audits related to quality assurance within the State Lead Program
3. Responsibilities and authorities of DEQ managers and staff for implementing the Quality Assurance Project Plan for the State Lead Program
4. The level of resources committed to implementing the quality assurance component of the State Lead Program
5. Procedural changes that may affect quality assurance within the program
6. Corrective actions taken to address deficiencies in QA/QC within the State Lead Program

The schedule for conducting Management System Reviews of the State Lead Program will be based upon time and changes within the program. The interval between Management System Reviews is expected to be approximately one year. Management System Reviews will also be performed when major State Lead procedures are changed.

4.2 Data Quality Assessment

Decisions made within the State Lead Program are highly dependent upon analytical data for samples that are collected by the State Lead Contractor or DEQ staff. Data must, therefore, be of sufficient and known quality to support decisions made by the DEQ Storage Tank Program Staff.

Data quality assessments will be performed to evaluate data collected for the State Lead Program to ensure that the data collected meet the Data Quality Objectives of the Program and ensure that corrective actions are taken if data quality is insufficient. The primary elements of assessing data quality within the State Lead Program will be data validation and data quality audits.

4.2.1 Data Validation and Corrective Action

Analytical data returned to the State Lead contractor or DEQ staff from the laboratory must be validated to ensure that the data are of sufficient quality to support the decisions that must be made about the site. The State Lead Contractor will review and validate data submitted for samples collected by their staff. The DEQ Regional State Lead Project Manager or State Lead Program Manager will review and validate analytical information for samples collected by regional staff or OSRR staff, respectively.

4.2.1.1 Holding Time

Holding time is an important element that must be considered when evaluating the quality of data. Persons checking information provided by the lab must review information provided about sample collection date and sample analysis date to ensure that the holding time for the requested analysis was not exceeded. If the holding time was exceeded, DEQ will consider the analytical result received and the type of decision that must be supported by the data.

When a holding time is exceeded, it is important to determine why the holding time was exceeded in order to prevent or reduce the probability of a repeat occurrence. The Regional State Lead Project Manager and the person who collected the sample (usually the State Lead Contractor) will review the sampling process used to determine why the holding time was exceeded. If the exceedance was attributed to the laboratory or to a site specific sample collection and handling procedure, the Regional State Lead Project Manager should document this conclusion in the appropriate case file. If the review indicates that standard sample collection procedures used by the State Lead Contractor and/or DEQ staff are causing holding times to be exceeded, the Regional State Lead Project Manager must notify the Storage Tank Program Quality Assurance Manager. The Quality Assurance Manager, Regional State

Lead Project Manager, the State Lead Program Manager, and the State Lead Contractor will revise the sampling procedure as needed to meet the holding times for the samples.

4.2.1.2 Blanks

If a rinsate (equipment), field, or trip blank was submitted to the lab, the State Lead Contractor and the Regional State Lead Project Manager will review analytical data provided for that blank. The presence of petroleum constituents or other organic analytes in a blank suggests that sample integrity may be compromised. If any analytes are detected in blank samples, the Regional State Lead Project Manager and the State Lead Contractor will evaluate the situation considering the data quality objectives for the samples and determine the appropriate course of action and the necessary corrective measures.

4.2.1.3 Qualified Data

Analytical data sheets provided by the lab should qualify the data presented on the sheet. DEQ staff and the State Lead Contractor should check the qualifiers to ensure that the data returned by the lab will support the decisions that must be made.

Qualified data may not be able to support the decisions that DEQ must make at a site. Common qualifiers that staff and the State Lead Contractor may encounter are listed in Table 4-1. Corrective actions needed when these qualifiers are encountered must be determined by the Regional State Lead Project Manager and the State Lead Contractor and will be based upon the data quality requirements for that data.

Table 4-1. Data Qualifiers

Qualifier	Description
J	The analyte was positively identified but the quantitation is an estimation
U	The analyte was analyzed for, but not detected. The associated numerical value is at or below the method detection limit
R	The data are unusable due to deficiencies in the ability to analyze the sample and meet QC criteria
B	The analyte was found in associated blank, as well as in the sample

4.2.2 Data Quality Audits

The Storage Tank Program Quality Assurance Manager is responsible for coordinating audits of data produced by DEQ staff and the State Lead Contractor for the State Lead Program. The Data Quality Audit will evaluate the quality of data generated by the State Lead Program relative to the Data Quality

Objectives. Analytical data sheets will be reviewed to determined if the detection limit for an analysis meets the data quality objectives, the sample was extracted and analyzed within the time limit specified for the method, and the analytical result was not qualified in such a way that might result in a failure to meet the data quality objective. Data Quality Audits also will evaluate the completeness of documentation related to sample collection and instrument calibration. The Data Quality Audit process primarily involves tracing the documentation that accompanies data from the time of collection to the time that data is used to make decisions. The State Lead Program Manager and a group of Regional State Lead Project Managers will assist with all Data Quality Audits.

4.3 Technical Assessments

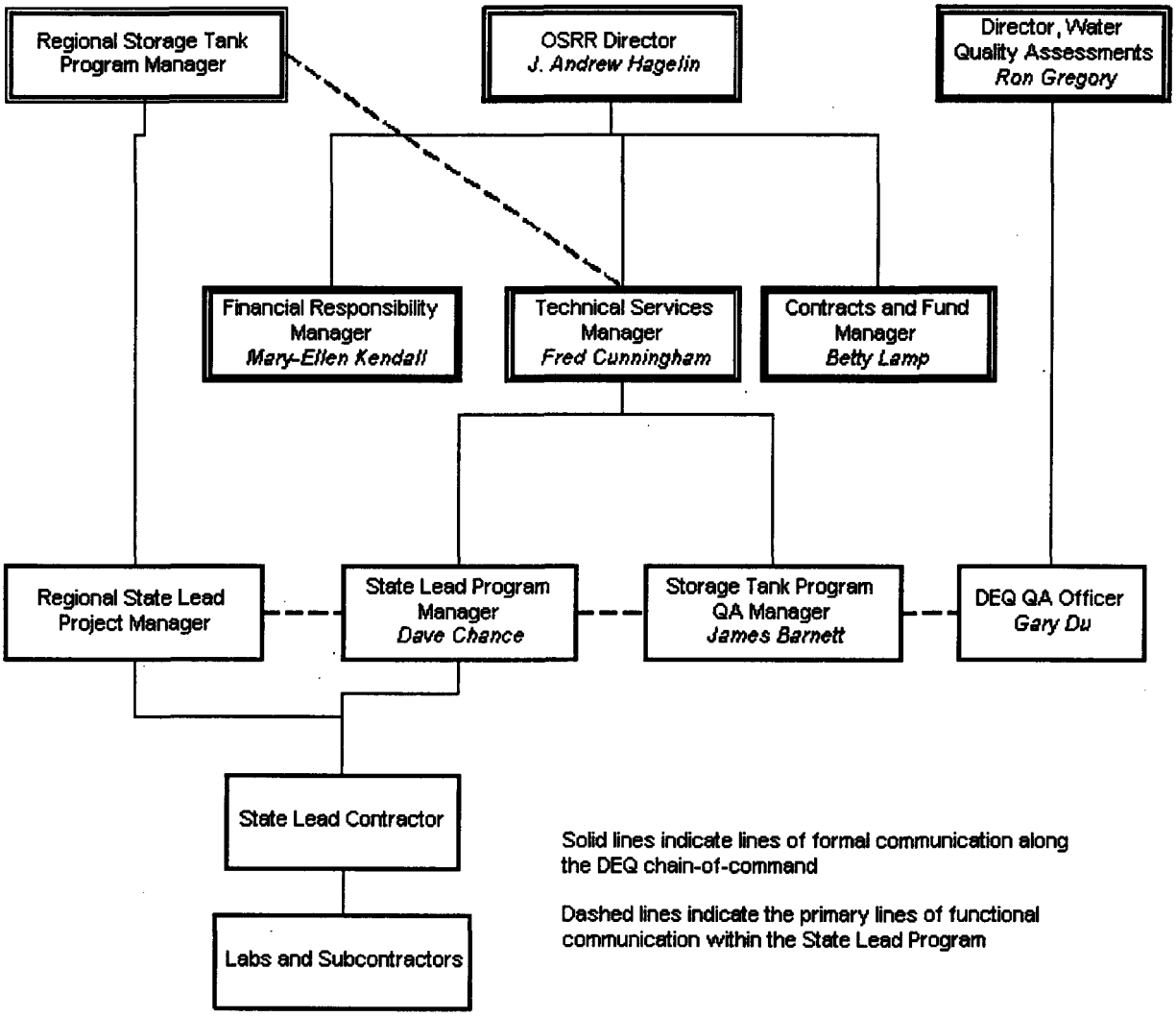
Technical Assessments will be conducted to assess the sampling and analytical quality control procedures used to generate environmental data at State Lead sites. The DEQ Storage Tank Program will use Technical Assessments to evaluate State Lead procedures described in the Quality Assurance Project Plan. Documents and information in the case files will be evaluated for conformance with State Lead procedures and documentation requirements outlined in the Quality Assurance Project Plan.

The Quality Assurance Manager for the Storage Tank Program is responsible for overseeing Technical Assessments. Regional State Lead Project Managers and the State Lead Program Manager also will be involved in the Technical Assessment process. The Storage Tank Program Quality Assurance Manager also may request assistance from other DEQ staff, including the DEQ Quality Assurance Officer, in performing Technical Assessments.

The first Technical Assessment for the State Lead Program will occur approximately 1 year after the implementation of the Quality Assurance Project Plan. The Storage Tank Program Quality Assurance Manager and the State Lead Program Manager may revise this schedule as necessary to account for changes in the program.

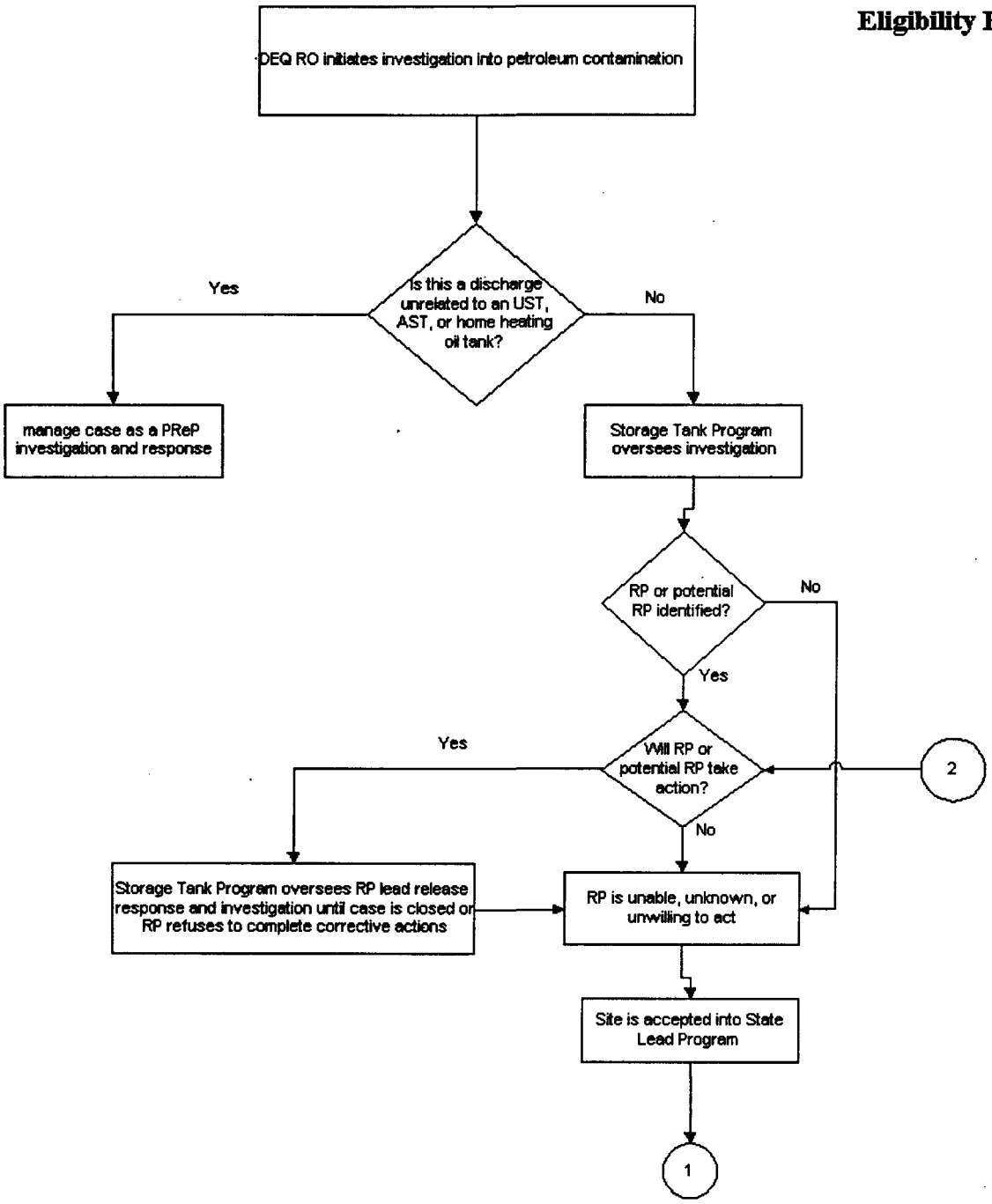
Appendix A
State Lead Program Organizational Chart

State Lead Program Organizational Chart

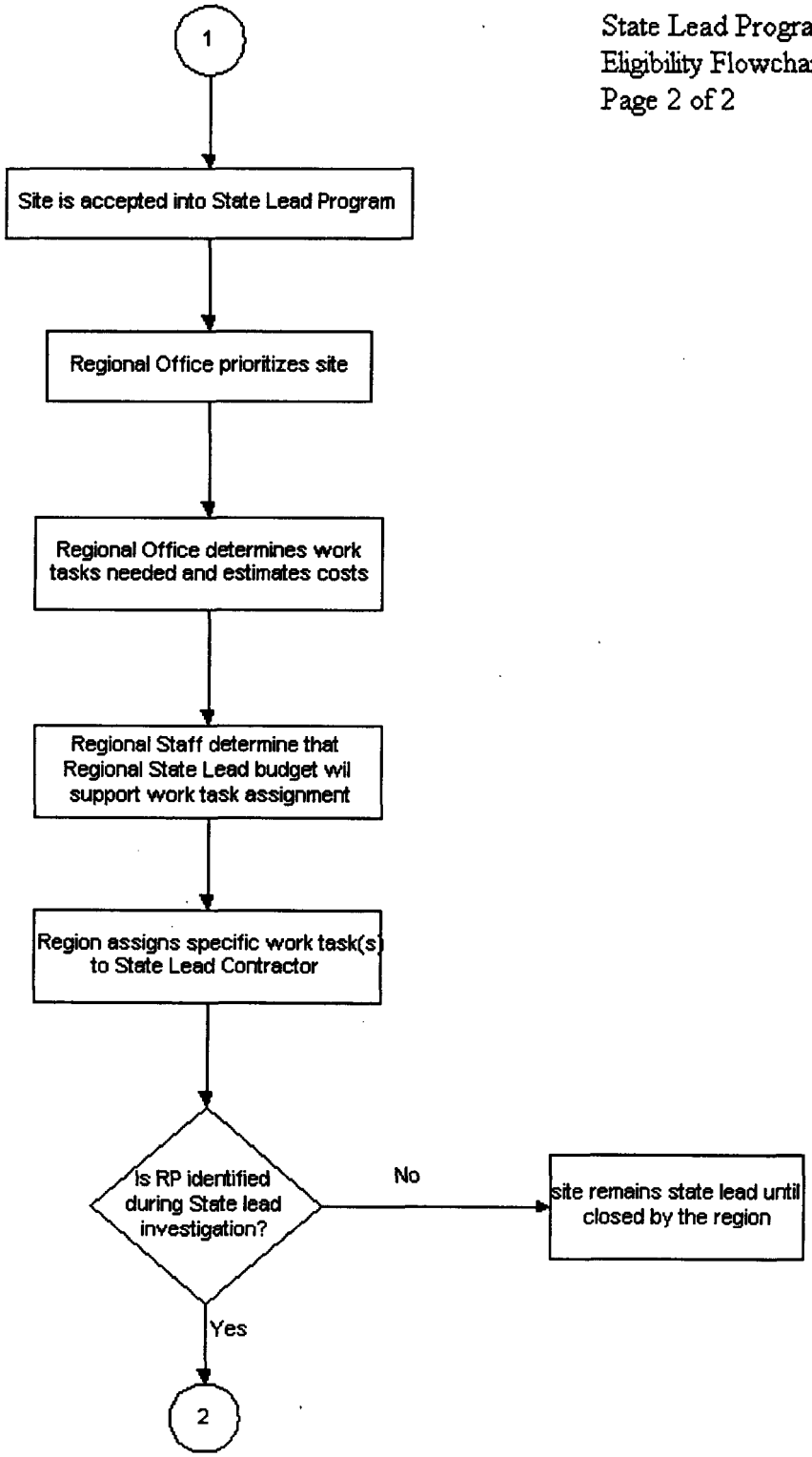


Appendix B
Flowchart for Determining State Lead Program Eligibility

State Lead Program Eligibility Flowchart

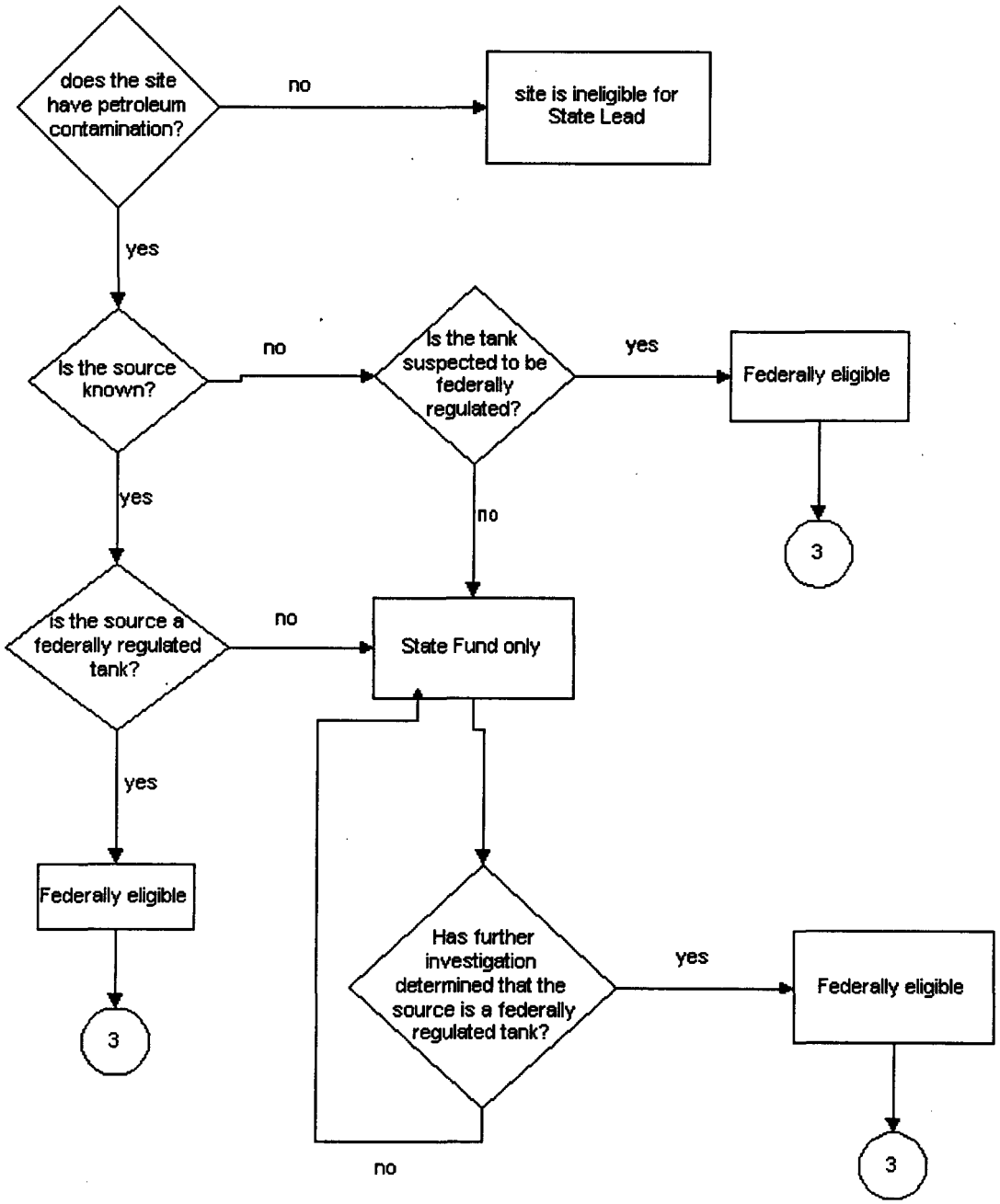


State Lead Program
Eligibility Flowchart
Page 2 of 2

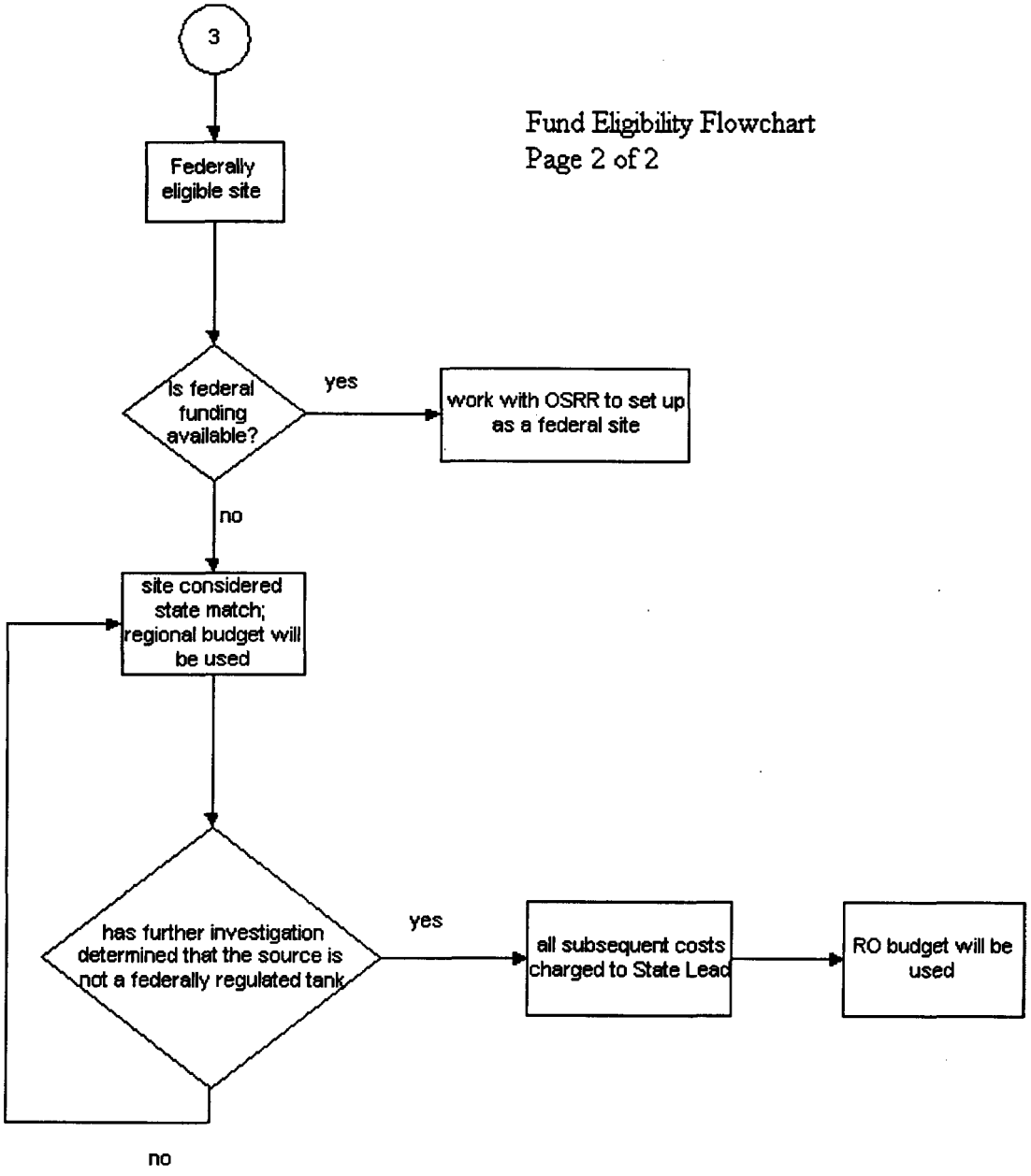


Appendix C
Flowchart for Fund Eligibility

Flowchart for fund eligibility



Fund Eligibility Flowchart
Page 2 of 2



Appendix D
State Lead Contractor Quality Assurance Procedures

QA Information to be Provided by the State Lead Contractor

I. Project Management and Responsibilities
   - A. Project Manager
   - B. Corporate QA/QC Manager
   - C. Health and Safety Officer
   - D. Staff Scientists/Engineers
   - E. Technicians
   - F. Other persons working on State Lead Projects

Discuss the roles and responsibilities of all persons who are expected to perform work related to the State Lead Contract. Provide information about organizational chain-of-command.

II. Sample Collection
   - A. Standard Sample Collection Procedures
     1. Ground Water
     2. Soil
     3. Soil Vapor
     4. Other
   - B. Staff Training in Sample Collection
   - C. Instrument Inspection, Testing, Calibration and Maintenance
     1. Portable Flame Ionization Detector
     2. Portable Photo Ionization Detectors
     3. pH Meter
     4. Conductivity Meter
     5. Temperature Probe
     6. Interface Probe
     7. Field Test Kits
     8. Other
   - D. Documentation
     1. Staff Training
     2. Instrument inspection, testing, calibration, and maintenance

Provide a description of standard sample collection procedures used by staff for ground water samples, soil samples, soil vapor samples, and other samples routinely collected during the course of performing release investigation, release response and corrective action at leaking storage tank sites. Discuss the internal procedures used to ensure that staff members are trained to collect samples in accordance with standard organizational procedures. List field instruments routinely used during the processes of investigating releases and performing release response and corrective action at leaking storage tank sites. Discuss the procedures your company uses to ensure that field instruments inspected, calibrated, tested and maintained in accordance with manufacturer's recommendations. Discuss the procedure used by your company to document: (1) staff training related to company standard sample collection

procedures; and (2) instrument inspection, calibration, testing, and maintenance.

III. Internal Document Management Procedures
- A. Field Notes
- B. Sample Labeling
- C. Chain-of-custody
- D. Analytical results
- E. Other

Discuss the internal procedures your company uses to document sample handling and integrity.

IV. Data Validation
- A. Data Review and Validation
- B. Reconciliation with Data Quality Objectives

Discuss the internal process used to review data generated for a site, validate that data and reconcile the data with data quality objectives.

Quality Assurance Procedures
Apex Environmental, Inc.

Apex environmental, inc.

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Quality Assurance Program Summary

Professional Resources

Apex Environmental , Inc. employs more than 150 professionals in technical disciplines including geology, chemistry, industrial hygiene, engineering, and construction management. Overall responsibility for the DEQ State-Lead program will be managed by Robert S. Williamson, PG, a Virginia-certified professional geologist with more than 15 years of experience. Mr. Williamson has performed or managed approximately 500 DEQ Pollution Complaint cases ranging from Initial Abatement Measures to Corrective Action.

Mr. Vincent N. DiRenzo, Jr., PG will serve as Apex's corporate Quality Assurance Officer. Mr. DiRenzo is Apex's Chief Operating Officer, and he will assure that Apex's full resources are available for successful implementation of this program. Key Project Managers are Christopher L. Cheatham, EIT, and Charles F. Crawford, both of whom manage multiple Pollution Complaint cases throughout the Commonwealth of Virginia.

Apex's corporate Health and Safety Officer is John Reinemann, CIH, a certified industrial hygienist with 20 years of experience. Apex can draw on the experience and skills of more than 100 staff professionals, and our offices in Richmond and Roanoke will support this program. Apex will work closely with the DEQ's Regional State Lead Project Manager to assure that task-specific goals are met efficiently and timely.

Quality Assurance

Apex employs internal and external training to assure that staff are qualified to conduct environmental monitoring and remediation safely and in a manner consistent with industry and DEQ standards. Sample collection procedures used by Apex professionals conform to method-specific protocol, such as SW-846 standards for sample preservation. Apex staff use dedicated sample collection devices, such as disposable HDPE bailers, disposable PVC gloves, and laboratory-grade sample containers, to reduce the potential for cross-contamination during sampling events. Samples are preserved in accordance with method-specific requirements, and all samples are managed using Apex's chain-of-custody documentation.

Apex owns state-of-the-art field monitoring equipment, including more than 10 photoionization detectors (PIDs), interface probes, water level indicators, pH, conductivity, salinity, and temperature meters, field assay TPH kits, magnetometers, dataloggers (for aquifer testing), and other equipment that may be required for environmental monitoring and testing. Staff are trained in equipment calibration, use, and maintenance. All staff are trained periodically using classroom and field exercises to assure that skills are current with industry standards. All staff have and utilize the DEQ Petroleum Program Manual to perform release investigation and corrective action in accordance with DEQ program requirements.

Sample integrity is assured through the implementation of Apex's Quality Assurance procedures for sample collection and handling, including equipment decontamination and chain-of-custody recordkeeping. Written documentation concerning all facets of project management, including field activities and protocol and data management, is maintained in the project file. Laboratory results are reviewed by the project manager and compared to the field monitoring results to assure consistency. Laboratory quality assurance results, both batch-specific and sample-specific, are reviewed to assure that test method criteria for quality control are satisfied. The sample chain-of-custody is reviewed to ensure that sample integrity is documented.

Document Management

Apex maintains its equipment in accordance with manufacturer's recommendations for calibration and maintenance. All maintenance and calibration activities are recorded in the project file for reference and to support data quality objectives. Project field notes, drilling logs, etc., are maintained in the project file for reference and backup. All original documents, correspondence, sample chain-of-custody records, analytical reports, permits, etc. are placed in the project file.

All data that are generated for a project are reviewed by the project manager as well as a Virginia-certified professional. Results, opinions, and recommendations are evaluated with respect to project data quality objectives to assure that project-specific criteria, such as DEQ's petroleum program, are satisfied. All work products are signed by a Virginia-certified professional.

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Quality Assurance Supplement

Sample Collection Procedures

Personnel who are collecting environmental samples are trained to conform to the following procedural guidelines. All field work, including sample collection, is overseen by a Commonwealth of Virginia-licensed professional geologist or professional engineer. The professional geologist or professional engineer is responsible for ensuring the staff are suitably trained and equipped to properly and safely perform field activities as specified in the project scope of work.

Samples that are collected for laboratory analysis are recorded on a sample chain-of-custody form (attached). The chain-of-custody form is used to document maintenance and transfer of samples and to demonstrate security of such samples.

Sample containers are obtained from the analytical laboratory. Sample containers are of laboratory-grade specification, batch-tested for quality assurance, and prepared with the appropriate preservative, if any, that is required by the method-specific criteria. Containers are not opened until the sample is retrieved.

All sample containers are labeled with a unique sample identification number which also is recorded on the chain-of-custody form and in the project field record.

Personnel wear disposable dust-free PVC gloves during all phases of sample collection and handling. Gloves are changed, at a minimum, between samples.

When possible, dedicated, disposable equipment is used for sample collection. Disposable HDPE bailers and nylon rope are used to collect groundwater samples from monitoring wells.

Soil samples are retrieved from sampling devices (split-spoons, hand augers, geoprobe sleeves) by selecting sample portions that are not in contact with the sampling device. A portion of the sample is transferred to the laboratory sample container, labeled, and stored on ice in a cooler. A portion of the sample also is placed in a sealable plastic bag, labeled, and used for field headspace screening and subsequent lithologic characterization.

Groundwater samples are collected from monitoring wells using dedicated, disposable HDPE bailers equipped with bottom-emptying devices. Monitoring wells typically are purged of a minimum of three standing well volumes (approximately 1.7 gallons per 10 feet of water column in a 2-inch well, and approximately 6.6 gallons per 10 feet of water in a 4-inch well), or until physical parameters (pH, spcific conductivity, temperature) are stabilized within 10 percent. Samples are collected in order of decreasing analytical sensitivity to volatility. VOCs are collected such that no headspace remains in the 40-milliliter sample vials. Sample containers are labeled, and stored on ice in a cooler.

Prior to sampling groundwater monitoring wells, depth to water is measured using a decontaminated electronic water level indicator. If free-phase petroleum product is suspected, an oil-water interface probe is used to measure depth to oil and water. Field decontamination procedures must conform to the project work plan. At a minimum, field decontamination includes a non-phosphate soap wash and triple rinse using deionized water.

Quality Assurance Supplement

Surface water samples typically are collected by directly inserting the sample container into the water body or by using a decontaminated PVC dip cup. If multiple sample locations exist in a flowing water body, the downstream samples are collected first. Sediment samples are collected similarly.

Soil vapor samples are collected using a Tedlar™ bag or through direct-reading instruments such as a photoionization detector (PID). In most cases, direct reading of total volatile organic compounds (VOCs) is required at petroleum release sites to reduce the quantity of samples submitted for laboratory analysis. The PID is calibrated according to the specific requirements provided by the manufacturer. Calibration data are included in the project log. Staff are trained in the proper use of the PID and level indicators by the manufacturer's representative. The maximum value observed on the instrument readout is recorded as the sample value. If vapor samples are collected for laboratory analysis, a Tedlar™ bag is used to retrieve the sample. Samples can be collected either via an existing air flow, such as the vent stack from a remediation system, or via mechanical means using an in-line air pump through nylon tubing to the bag inlet port. Samples should be delivered directly to the analytical laboratory to assure that method holding times are not exceeded. The chain-of-custody form must accompany the sample to document sample integrity.

Staff Training

Apex promotes staff training through periodic classroom training that is conducted by senior staff. Field methods, equipment operations, regulatory awareness, and safety are included in the periodic training. Entry-level staff are provided extensive field training by mid- and senior-level professionals. Staff acquire the skills and knowledge through hands-on project activities under direct supervision. Documentation is accomplished through regularly scheduled performance reviews with employees. During these reviews, supervisory personnel evaluate the achievement of established goals in areas including field performance, report preparation, and regulatory knowledge. These reviews are documented and are included as part of Apex's personnel records.

Apex's corporate Health & Safety Officer, John Reinemann, CIH, is responsible for overall corporate safety and health awareness. Robert S. Williamson, PG, Apex's Virginia Regional Manager, is responsible for all quality assurance matters relating to Apex's services in the region.

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CHAIN OF CUSTODY RECORD

JOB NO.	JOB NAME	PROJECT MANAGER
SAMPLER(S): (Signature(s))		(Printed)

SAMPLE ID	DATE	TIME	COMP.	GRAB	MATRIX	PRES.	STATION / LOCATION	NO. OF CONTAINERS	PARAMETERS									TURN-AROUND TIME / REMARKS
							TOTALS											

Relinquished by: (Signature) ①	Date/Time	Received by: (Signature) ②	Relinquished by: (Signature) ③	Date/Time	Received by: (Signature) ④
(Printed)		(Printed)	(Printed)		(Printed)
Relinquished by: (Signature) ⑤	Date/Time	Received by: (Signature) ⑥	Remarks		
(Printed)		(Printed)			

Distribution: WHITE => original (accompanies samples; returned with results) : YELLOW => laboratory copy : PINK => sampler's copy

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GENERIC PROJECT QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) PLAN ENVIRONMENTAL PROGRAMS

GENERIC PROJECT
QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) PLAN

Apex Environmental, Inc. (Apex), has developed a Quality Assurance (QA)/Quality Control (QC) Plan as a demonstration of its commitment to providing the highest level of customer service. The QA/QC documents Apex's standard approach to the collection, analysis, and interpretation of data. The Plan also provides a means of measuring the quality of Apex's procedures and interpretation of environmental data. As with all QA/QC Plans, this is a living document to be revised and updated as procedures change, equipment improves, and requirements broaden.

The project QA/QC Plan details the procedures necessary to ensure data quality during the sample planning and collection phases, the laboratory analysis phase, and the data processing and interpretation phase. The Plan ensures that the procedures used during sample collection and analysis will not detract from the quality of the data results, and to ensure that all activities, findings, and results follow an approved plan and are documented. Quality assurance consists of two distinct and equally important functions. One is the assessment of the quality of the data by establishing their precision and accuracy. The other function is the control, and improvement by corrective action, of the quality of the data by implementation of specific policies and procedures. The two functions form a control loop--the QA/QC Plan. A copy of the QA/QC Plan will be provided to the project team members and subcontracted field personnel before sample collection and each laboratory prior to receipt of samples.

Some key definitions that should be clarified for use in this plan are quality assurance, quality control, and assessment/appraisal.

Quality Assurance: Quality assurance involves all those planned and systematic actions necessary to provide adequate confidence that a facility, structure, system, or activity will perform satisfactorily and safely.

Quality Control: Quality control, which is included in quality assurance, comprises all of those actions necessary to control and verify the features and characteristics of a process to specified requirements.

Assessment/Appraisal: Assessment and appraisal is a planned and documented activity performed in accordance with established procedures to determine, by examination and evaluation of objective evidence, the adequacy of and extent to which applicable

elements of the quality assurance program have been developed, documented, and implemented according to specified requirements.

The major elements of the project QA/QC Plan will include:

- Project description and Statement of Work;
- Project organization and responsibility;
- QA objectives for data in terms of precision, accuracy, completeness, representativeness, and comparability;
- Sampling procedures;
- Required sample preservation, containers, and holding times;
- Field screening and laboratory analytical procedures;
- Sample chain-of-custody documentation procedures;
- Data reduction, validation, and reporting;
- Internal quality control checks and worker performance;
- Laboratory required performance and system audits;
- Corrective action for invalid data or field equipment breakdowns; and
- Data management.

A distinction should be made between field and laboratory quality control. Any laboratory analyzing environmental samples must have a laboratory QA/QC Plan, which is shown as an attachment to the Project QA/QC Plan. The laboratory's QA/QC provides adequate controls only for the laboratory functions and cannot be used to ensure the quality of the entire sampling and analysis process. Consequently, the QA/QC Plan should provide adequate controls on those activities conducted in the office and the field.

QA/QC for site work provides records of traceability and adherence to prescribed protocols, complete descriptions of relaxed or lax quality control, and corrective actions along with data on the quality of the data collection and analyses, deficiencies that may affect quality, and the uncertainty limits for results.

1.0 PROJECT DESCRIPTION AND STATEMENT OF WORK

This section is specific to each site and is tied directly to the Scope-of-Work. The objectives of the study should be stated in this section, along with whatever is known that could impact the data that are collected.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

Apex supports a line management project structure. The Director of Environmental Services is ultimately responsible for the success and the technical integrity of this project. She ensures that all contractual matters are resolved in a timely manner, including subcontracts. She also ensures that each phase of the project is conducted in such a way as to fulfill the project objectives and to minimize the costs. She has corporate responsibility for ensuring that the resources of the firm are made available to the project manager and that the QA/QC program is followed.

The Project Manager is responsible for the technical execution of the project, along with the day-to-day tracking of the progress, budget, and schedule. The Project Manager will also serve as a technical leader and will draw upon his experience at similar sites to guide and direct the project team.

The project QA/QC Officer is responsible for implementing the QA/QC Plan. This person reports directly to the Director and can monitor adherence to the Plan at all levels of the project. The QA/QC officer can perform, or assign a suitable person to perform QA/QC audits and spot checks to ensure adherence to the Plan.

Subcontractor management will be coordinated by the Project Manager. Apex subcontractors are firms who are committed to performing high quality work and who generally have an established working relationship with Apex.

There are several major elements to the QA/QC project program. The Director and Project Manager are part of the technical staff directly involved in running and managing the project. The Technical Peer Reviewer(s) are senior technical staff members with expertise in the project area but no direct involvement in the execution of the project. The QA/QC Officer is a team member who reports directly to the Director and who is responsible for the implementation of the QA/QC Plan. In addition to personnel, there are several project plans that must be used in conjunction with the QA/QC Plan to enable the implementation of the QA/QC program. These are the Sampling and Analysis Plan, the Work Plan, and the Health

and Safety Plan. Much of the QA/QC program depends on the successful adherence to these plans.

The project staff must work together as a team. No one person will be making the decisions for the project. Apex strongly believes that a variety of perspectives is both valuable and necessary to a well-conceived and executed project. The management team, along with the technical peer reviewers, will serve as senior technical experts to the project and guide the conceptualization of many of the ideas used during the performance of the work. Other team members, such as chemists, engineers, geologists, and regulatory experts, will be utilized as the project warrants it, to provide a well-balanced, technically expert resource to the client.

3.0 QA OBJECTIVES FOR DATA

The Sampling and Analysis Plan defines routine procedures and protocols that will be used to collect and analyze field data. The data collection and level of quality must be consistent with the scope-of-work and project objectives. The Sampling and Analysis Plan sets forth the type, number, and location of all samples to be taken or collected during the course of the project. It details the collection procedures, decontamination procedures, sample containers, holding times, preservation methods, and other specific technical details to be followed in the field. The Sampling and Analysis Plan also spells out the analyses to be performed, the level of laboratory QA/QC required, and the method of reporting the results. The Sampling and Analysis Plan, along with the Work Plan will be used in conjunction with the Health and Safety Plan and QA/QC Plan to constitute the basic procedures to meet the QA objectives for each particular site.

Quality control samples are collected routinely during the course of the project. Whenever possible, as part of the external quality control program, quality control samples should be submitted to the laboratory along with routine samples in such a way that the laboratory does not know which samples are quality control samples. These external quality control samples usually consist of duplicates and blanks and are used to monitor the integrity of the sampling, decontaminations and precision and accuracy of the analysis, as well as being used to rule out external interference from ambient air or shipping conditions. In addition, the laboratory is expected to run internal quality control samples that will indicate whether analytical procedures are meeting quality expectations. The quality control samples that are routinely used consist of five basic types: blank samples, replicate (duplicate) samples, reference (standards) materials, control samples, and spiked samples.

These are discussed in the context of data quality objectives in the following paragraphs.

3.1 Precision

Analytical precision is maintained by adherence to methods and is evaluated by comparison of results between replicate measurements. While replicate analysis may be precise with little deviation between the results, they may not necessarily be accurate. Replicate samples are obtained by repeating collection and analysis of the samples, but often only replicate aliquots of the same laboratory sample are analyzed. Soil samples, due to their highly heterogeneous nature, are infrequently collected as duplicate samples. If such material is taken into solution before being analyzed, replicate subsamples of the solutions are often analyzed. However, liquid and vapor samples are routinely collected as duplicates. In a typical program, ten percent of the sample quantity is collected in duplicate to monitor precision.

Replicate or duplicate samples are collected from the same sampling device and as close to the same time as physically possible. Splits, or samples collected by pouring liquid into duplicate bottles in small increments to ensure maximum mixing, are the most common way to collect duplicates. Air sample duplicates are filled sequentially. The requirements of a specific program dictate the exact nature of the precision monitoring. Second column confirmation may also be a procedure, particularly when analyzing for volatile organic compounds, to check on analytical precision.

3.2 Accuracy

Accuracy is maintained through rigorous instrument calibration and reagent standardization procedures using standards specified in analytical methods and calibration procedures specified by the manufacturer of the instrument. Methods are followed strictly and method accuracy is checked out routinely with appropriate control samples, standard reference solutions, spikes (individual compounds and/or surrogates), internal standards, and audits (both performance and system audits). Reference material or standard reference material is used primarily to calibrate the measurement method or apparatus. Performance audits are external evaluations comparing laboratory results on blind samples against standard values. System audits are random on-site qualitative inspections and reviews.

Spiked samples are prepared by adding a known amount of the constituent of interest to blank samples with known concentrations. They may be used to estimate chemical yields of the analytical process (percent recoveries). Where the presence of other constituents in a sample may be affecting the response of an instrument, multiple spiking may be done. In this process, a series of samples are spiked by the addition of increasing amounts of the constituent of interest. The measured values are inspected to determine whether the instrument yielded a linear response to the increasing concentrations, and whether the rate of increase correlated well with the increase in concentrations. For the purposes of most programs, ten percent of the analysis that is performed will be devoted to QA/QC samples.

Blank samples are analyzed to give a measurement of any contamination of the sample that is occurring during the course of collection, preparation, or analysis. The field sampler or analyst usually introduces blanks into the sample stream. Often these are trip blanks, equipment blanks, field banks, or reagent blanks. Reagent blanks are prepared by using deionized water and going through all of the procedures normally involved in a particular analysis, including adding the reagent at the proper places. Trip blanks are routinely used with each sample shipment. They are prepared in the laboratory using cleaned glassware and HPLC water and are not opened until the completed field samples reach the laboratory for analysis. Field blanks, used only when the Project Manager or chemist believe that ambient conditions in the field, such as airborne particulates or vapors, might have an impact on the analytical results. These samples will be taken on a case-by-case basis. Equipment blanks are used to ensure that the equipment is adequately cleaned between individual sampling events and to check on possible cross-contamination. They are taken by pouring HPLC water over or through cleaned equipment during the course of the sampling. It is usually sufficient to collect one equipment blank for every ten sampling points, but this frequency may be increased in areas where high concentrations of chemicals exist or where difficult to clean equipment is being used. These blanks are typically analyzed for the same parameters for which the environmental samples are analyzed.

3.3 Completeness

Data gaps will be identified in the scoping of the project, as existing information is reviewed. As new data are generated, continual review will be performed for data completeness. Certain data are necessarily linked. For example, ground water measurements without well elevation data would not

be considered complete for the purposes of characterizing a site. In another example, analytical data without detection limits would not be considered complete. Requirements for data completeness will be clearly detailed in the Work Plan or the Sampling and Analysis Plan. Technical peer review at project milestones will ensure that the data being collected are both complete and appropriate to meet the project objectives.

3.4 Comparability

Collected data can be directly compared only if the factors that impact the data do not vary either spatially or temporally. Because of the dynamic nature of the chemistry of a site, site chemical data are only directly comparable if collected very close in time or at the same location. Seasonal variations, variations in depth or location, variations in the sample collection, preservation, or analytical methods will all make direct comparisons of data invalid unless these factors are both taken into account and corrections are made to the data sets that cancel out the effects of these variations, if possible. Where there are no variations in these factors, where adequate care has been given to the precision and accuracy of the data, and where there is consistency in the protocols and procedures, site data may be comparable. Where variation factors exist, comparison of the data may still be valuable to quantify the impacts of such factors. Thus, graphical techniques, mapping, and other presentations of the data may be invaluable in data analysis.

3.5 Instrument Calibration

To maximize the quality of the data produced, every effort will be made to keep abreast of the state of the art in instrumentation used in environmental work. To keep instruments performing efficiently, a schedule of preventive maintenance is followed. A record of instrument performance is maintained, and any modifications made in the instruments are documented. Provisions will be made for the periodic, quantitative assessment of the performance of most instruments. For many, calibration standards are available. These standards are measured to obtain a curve that relates the intensity of the signal from the instrument to the concentration of the substance or the intensity of the property being measured. In other instances, this calibration consists of a one-point check using a single standard reference instrument, source, material, or sample. For the quality of the measurements to be optimized, the operator must use the appropriate standards, calibration procedures and frequency, and must keep a record of the traceability of the standardization. Field instruments will be calibrated as needed, but at least

on a daily basis. Calibration will be done by means of purchased standards and performed by trained field or laboratory personnel.

4.0 SAMPLING PROCEDURES

Sampling procedures are outlined in detail in the Sampling and Analysis Plan attached to the QA/QC Plan. The QA/QC Officer and the Project Manager will ensure that these procedures are strictly followed, and any variations that are deemed necessary, such as those based on differing site conditions, are detailed in a modification to the Plan and are adequately communicated to the entire project team. Full documentation of these modifications will be placed in the project file.

4.1 Quality Control for Soil Gas

QA/QC for a soil gas survey is done in several ways. First, all down-hole equipment coming into contact with the soil gas is thoroughly decontaminated between the collection of each sample. Secondly, collection of several types of quality control samples is done, including duplicate samples, field blanks, and matrix spike blanks. Finally, a strict Chain-of-Custody is maintained for the samples. In addition, field screening of soil gas at each sampling point is done with a direct-reading photoionization detector (PID) device to screen the area for gross contamination. The PID is calibrated using isobutylene upon arrival at the site and daily while in the field. At the end of each day, all instruments (PID and gas chromatograph) are recalibrated. The GC is calibrated a minimum of twice a day with certified gas standards, including four target compounds as well as a library of other common volatile organic compounds. Syringe blanks are run after high-concentration samples to check for cross-contamination of samples.

5.0 REQUIRED SAMPLE PRESERVATION, CONTAINERS, AND HOLDING TIMES

Many types of measurements of environmental materials require that a sample be collected and returned to the laboratory for analysis. These samples may require some form of preservation before they can be analyzed. Where possible, groups of samples that are expected to contain high concentrations of an analyte are processed independently from those with low concentrations to minimize the possibility of cross-contamination. Preservation and pre-treatment normally alters the physical state of the sample, and sometimes alters its chemical state. In planning the pre-treatment and preservation, one must consider the nature of the measurement that

is to be made and the state the sample must be in to undergo the measurement. The possibility should also be considered that the results obtained from analysis of the sample might lead to a desire to analyze it again for the same property or for a different property. Hence, it may sometimes be prudent to collect more samples than will be immediately be processed and to process more samples than will be immediately analyzed. Portions of the sample that are to be saved should be entered into the project file and stored at the laboratory.

The protocols to be followed for sample preservation, sample containers, and holding times are outlined in detail in the Sampling and Analysis Plan attached to this QA/QC Plan. Each analyte has specific requirements and the details must be spelled out before any samples are collected. The QA/QC Officer and the Project Manager will ensure that these procedures are strictly followed, and any variations that are deemed necessary, such as those based on differing site conditions, are detailed in a modification to the Plan and are adequately communicated to the entire project team. Full documentation of these modifications will be placed in the project file.

6.0 FIELD SCREENING AND LABORATORY ANALYTICAL PROCEDURES

Some measurements of environmental parameters are performed in the field and called field screening. Others are performed in the laboratory on samples that were collected in the field. In either situation the procedures performed in the field must be done correctly if the measurements are to produce valid results. There are many potential pitfalls involved in this initial step and precautions must be taken to avoid them to ensure the validity of the final data. Before sampling is begun, all project personnel should be informed of the procedures to be used so that consistent and appropriate techniques are used by all team members.

The field screening and laboratory analytical procedures are fully outlined in the Sampling and Analysis Plan attached to this QA/QC Plan. The discussion of data quality (Section 3.0 of this Plan) applies to all data generated, whether in the field or the laboratory. Strict adherence to the protocols and procedures outlined in the Sampling and Analysis Plan will be demanded of the project team by the Project Manager and Director, as well as the Technical Peer Reviewer. The QA/QC Officer and the Project Manager will ensure that these procedures are strictly followed, and any variations that are deemed necessary, such as those based on differing site conditions, are detailed in a modification to the Plan and are adequately communicated to the entire project team. Full documentation of these modifications will be placed in the project file.

7.0 SAMPLE CHAIN-OF-CUSTODY DOCUMENTATION PROCEDURES

At the time of sample collection or field measurement, samples and resulting data sets are normally given unique code numbers that serve to identify them during subsequent analytical, calculation, and data reporting stages. Sometimes a coding system separate from that used in the field is used by the analytical laboratory, either for convenience or to ensure the "blindness" of the quality control samples or measurements. Care must be taken to mark samples and field data clearly to minimize the possibility of misreading the labels and notes. It is often desirable to use codes that contain information on the site and time of sampling, as well as the nature and location of the sample. This information is attached to the sample container and also written on the Chain-of-Custody forms for each sample shipment.

Chain-of-Custody is a means to ensure sample integrity by documenting who has had possession of a sample and where it has been from the point at which it was collected until it is analyzed. The field sampler initiates the Chain-of-Custody by filling out the standard form for each sample collected. Apex's blank Chain-of-Custody form is attached to this document. The form must be filled out completely and a copy kept by a representative of the field team to be placed in the project file. Once a sample is turned over to the person responsible for transporting it to the laboratory (for example, Federal Express) and laboratory personnel logging it into the laboratory, the Chain-of-Custody form is modified to include those additional personnel in possession of the samples. In cases where it is necessary to ensure that the samples have not been opened prior to arriving at the laboratory, Chain-of-Custody seals for the bottles or the coolers in which they are packed can be used. Once the laboratory has received the sample and completed the Chain-of-Custody form, it is returned to the originator to be kept in the project file. The Chain-of-Custody form can also be used to cross-check what samples have been collected and what analyses have been performed on which samples, as it is a detailed record of there activities.

The storage of all samples shall be conducted under controlled conditions predetermined to prevent breakage or loss, to minimize deterioration, and to assure safety of handling personnel. The packaging and shipment of all samples shall be done in a manner to minimize breakage and to be consistent with prescribed preservation requirements.

8.0 DATA REDUCTION, VALIDATION, AND REPORTING

The quality of the data reported depends not only on the care with which sampling and analysis are performed, but also upon the care with which calculations of the resulting data are performed and upon the manner in which data are presented in a report. A key aspect of a quality assurance program is maintaining records that document every step of the process that leads to the data that ultimately are reported.

8.1 Data Reduction

Data reduction consists of converting raw data into data capable of being analyzed by means of some form of manipulation, comparison, or presentation. Raw field or laboratory data often require some calculations, unit conversions, or other manipulation prior to project team interpretation. The field notes taken during an investigation normally provide a basis for judging the representativeness of a sample or a field measurement. Similarly, laboratory notes made during the analysis of a sample serve as a basis for judging the quality of the analyses, indicating whether any problems arose during the analytical procedure that may have adversely affected their outcome. For this reason, every effort should be made during field work and analysis to keep complete, accurate, and legible notes of all activities. These records are kept by a member of the project team until that particular activity ceases, then they are transferred to the project files.

All calculations are documented on paper and kept in the project file. Each calculation sheet is initialed and dated. It also contains significant project information such as the project number, task number, or project phase. All calculations must be checked by either another member of the project team or an independent reviewer. Mistakes are crossed out and recalculated next to the mistake. Calculations performed on the computer are spot checked by hand calculations whenever practical. Independent review of the programs being used is performed as part of the technical peer review process. Whenever possible, raw laboratory data will be imported to computer files used by the project team. This reduces the time necessary to reduce the data and eliminates transcription errors. All tables will be checked by the technical editor during the editing process for such things as typographical errors, transcription errors, missing units, inconsistencies, and reasonableness.

8.2 Data Validation

There are several steps to data validation. These include determination of:

- data validity;
- data sufficiency; and
- data sensitivity.

8.2.1 Validity

Quantitative evaluation of data is essential. Validation analyses should be performed on all existing data before the Sampling and Analysis Plan is developed to ensure that errors are identified and any necessary resampling is scheduled. The data and supporting documentation should be evaluated. This is similar to a quality assurance audit. Data may be considered valid only if the following information is available:

- sampling data
- identity of sampling teams or person in charge
- sampling location and description
- sampling depth increment
- collection technique
- field preparation technique
- laboratory preparation technique
- laboratory analytical methods
- laboratory detection limits.

Data validity may also be checked using statistical cross-validation procedures.

8.2.2 Sufficiency

Determining data sufficiency means answering whether the data are sufficient to adequately characterize the site. This determination involves defining the number of samples of each matrix that are necessary and sufficient to satisfy the sampling objectives. Statistically, data sufficiency involves determining whether confidence levels for measured or predicted values are rigorous enough to satisfy regulatory and engineering criteria. Various statistical methods can be used to

plan sampling that will efficiently meet this certainty requirement. Similarly, the sensitivity analysis may suggest that no additional sampling is required.

8.2.3 Sensitivity

During the initial phase of data evaluation, sensitivity studies may be performed to determine the impact on site assessment if additional sampling is not performed. Methods are available that may be used to calculate the range of probable values at nonsampled locations and to determine the effect of this uncertainty on site assessment. One example of this method is kriging (Journal and Huijbregts, 1978).

9.0 INTERNAL QUALITY CONTROL CHECKS AND WORKER PERFORMANCE

For Apex, quality is a fundamental part of our business. Apex ensures quality on our projects by the implementation of a QA/QC Program. This program was initially developed for our work on Department of Energy contracts, but is suitable, with some modification, for use on all projects involving field work and laboratory analysis. The major aspects of our program include:

- Agreement at the proposal stage by the key project team members that the project has an adequate scope, budget, and schedule;
- Definition of senior technical peer reviewers for all major deliverables and work products;
- Preparation of Project Instructions to define the project objectives, budgets, schedules, and responsibilities, as well as clearly defining the project administrative requirements;
- Scheduling of a project kick-off meeting where the project instructions are reviewed by the project management team, peer reviewers, and key project personnel;
- Periodic evaluation of quality with the client to ensure that their expectations are being met; and

- Scheduling a project wrap-up meeting of the project team leaders to review and evaluate project performance according to the quality specifications.

Key to the successful performance of the work is a clear understanding by each team member as to what their project responsibilities are and what the objectives and procedures for meeting the objectives are. This is done through project instructions.

9.1 Project Instructions

The project instructions become a dynamic working document that every member of the project team uses for planning work and measuring progress. Apex requires preparation of project instructions for each project performed. The project instructions are a comprehensive planning document that serves to convert project needs into a practical and executable plan. They are designed to promote efficiency in work planning and execution, and are critical planning documents for the staff. The major elements of the project instructions are outlined below, but are specific for each project:

- Project-identifying data (project and task numbers);
- Confidentiality requirements;
- Project summary and scope;
- Detailed work plans;
- Schedule;
- Budgets;
- Definition of reports/deliverables;
- Guidelines for internal and client communications;
- Health and safety requirements;
- Subcontractor management; and
- Project file location and responsibility.

9.2 Project Tracking

Once the project is initiated, the project team uses a standard, computerized accounting report to monitor budget performance. The reports are compiled and distributed twice each month to the Project Manager. The information from these reports is used to track and report total costs and progress twice a month. Elements of the project that are "fast-tracked" and needing more timely review than twice a month are tracked weekly by hand.

9.3 Technical Peer Review

A formalized system for technical peer review for all project reports and deliverables is initiated at the proposal onset. Senior technical managers or those technical staff members with familiarity with the type of project, but are not members of the project team, are used for technical review. A technical peer review sign-off sheet accompanies each document as it is reviewed and edited.

9.4 Worker Performance

The Project Manager will have primary responsibility for assuring that all workers involved in the project are acting in a manner that will produce only the highest quality work. Each member of Apex's field team will have responsibility to collect data as well as provide feedback to the Project Manager on personnel or equipment deficiencies: Furthermore, the Project Manager will have daily contact with the field team to assess team performance and progress. In the unlikely event that a field team or team member is performing poorly in the judgement of the Project Manager or client, remedial action will be performed to avoid negative impact on the project. This remedial action could take the form of additional coaching, assignment of a more experienced "buddy" to oversee their work, or, in extreme cases, removal from the team. Because Apex has all of its employees on a Management by Objectives program, performance will be tied to specific goals and a time frame, and the resources of the company will be used to improve that employee's performance, if necessary. Monitoring of this employee's performance will continue throughout the project and replacement will be instituted if desired improvement is not detected. This will be done in a manner so as not to impact the schedule or budget.

9.5 Subcontractor Performance

Subcontractor performance also will be evaluated by the Project Manager. The selection of the subcontractor will be based upon qualifications, price, and a professional association with Apex or its personnel. This allows Apex to select subcontractors who are proven reliable and proficient. Nevertheless, the Apex field supervisor will monitor all on-site subcontractor performance and individual Apex personnel will be assigned to subcontractor crews to provide direct supervision of the subcontractor's activities. Under no circumstances are subcontractors allowed to conduct site work without an Apex representative present. If deficient performance occurs, immediate

actions will be taken to correct the situation and minimize the impact to the project. In extreme cases, the subcontractor will be dismissed.

The performance of the analytical laboratory will be continual, based upon the QA/QC samples that are submitted as well as the data validation performed by Apex once the analytical results are received. In the event that analytical data are deficient, the Project Manager will direct the laboratory to identify the cause of the deficiency, correct the problem, and reanalyze the samples. In the event that deficiencies continue, the laboratory will be dismissed. This may require the recollection of environmental samples and analysis by another laboratory.

10.0 LABORATORY REQUIRED PERFORMANCE AND SYSTEM AUDITS

Quality assurance programs are developed and used by analytical laboratories to guarantee delivery of valid and reliable data. Functions to control the quality and completeness of sample results in the laboratory include, but are not limited to:

- **Analytical methods:** utilization of published and standardized procedures;
- **Reagent control:** utilization of analytical reagents conforming to specifications of the Committee in Analytical Reagents of the American Chemical Society;
- **Volumetric glassware:** high quality measuring devices;
- **Calibration standards:** specifically prepared, known quality reagents for system checks;
- **Blanks:** both batch and method blanks should be used;
- **Calibration procedures and frequency:** defined program to conduct calibration tests;
- **Control samples:** known reference standards;
- **Duplicate analysis:** replicate analyses on a defined percentage (usually 10 percent) of samples;
- **Spiked samples:** used to verify presence or absence of matrix interference;

- **Corrective measures:** defined procedures to handle accuracy and precision problems;
- **Data validation:** review of results by supervisory personnel;
- **Glassware cleaning:** housekeeping procedures to return equipment to the appropriate level of "clean";
- **Equipment maintenance:** routine servicing of equipment; and
- **Training:** utilizing technicians and staff who are qualified by experience.

A copy of the laboratory QA/QC program is attached to this document.

11.0 CORRECTIVE ACTION FOR INVALID DATA OR FIELD EQUIPMENT BREAK-DOWNS

The Project Manager will be kept informed by all team members as to when project data or activities do not meet the requirements of the Project QA/QC Plan. This function will formally be performed by the QA/QC Officer, who will periodically perform audits on various aspects of the project. In the event that invalid data are discovered, an attempt will be made by the appropriate team member, under the direction and supervision of the Project Manager, to discover the source of the problem. QA/QC procedures will be reviewed to find any deviations. In the event that data are invalid, new measurements or additional samples will be collected. If sampling procedures were at fault, new procedures will be implemented and the project team trained in the new procedures. If the analytical laboratory was the problem, steps will be taken to identify and correct the problem. Duplicate samples will be collected when the problem cannot be identified or corrected, and split samples will be sent to different laboratories for duplicate analyses. QA/QC procedures at the laboratory will be increased until there is confidence in the analytical results that are being produced.

In the event of equipment failure, backup equipment will be used. Because equipment is continually being checked and calibrated, malfunctions should be fairly easy to spot. The malfunctioning equipment will be replaced with the backup unit, and the broken equipment will be sent to the factory for service and recalibration. If the equipment is the only unit available to the project, field work will be temporarily discontinued until a replacement unit can be obtained or until the unit can be replaced with an equivalent unit. Questionable data will be retaken.

Corrective action requires adequate and detailed documentation of the problems, when the problem was first suspected, what actions were taken to correct the situation, and how the corrective action could be expected to impact the objectives of the project. If there is an impact to the budget or schedule, the client must be consulted and approve of the corrective action that will be taken.

12.0 DATA MANAGEMENT

Site characterization and sampling are conducted to verify existing data and to fill data gaps for subsequent and concurrent work. Documentation and record-keeping procedures are most important during the collection of data because these steps produce the basis from which all project decisions are made. The most important aspects of data management are the production of QA/QC project plans, the establishment of a data security system, detailed work plans, a detailed Sampling and Analysis Plan, and an adequate retrieval system.

12.1 Data Security and Retrieval

A data security system and retrieval system are specific to the project requirements. Routine projects are managed by the use of a central filing system, within which all project materials are stored. This filing system is maintained by a file clerk, and all retrieval from the system is made by means of checkout documents. Working files may be kept in the Project Manager's office only if they are duplicated in the central files. Files are subdivided into standard categories that suit site investigation and remediation work, including business files, technical data files, correspondence files, and reports/deliverables files. Those projects that require secure files will be locked when not in use, with the key given only to the office security officer and office manager. Each document that should be stored in this secure file should be so marked, on every page. Usually this stamp involves confidential work products or those under attorney/client privilege.

12.2 Data Storage

When data are stored electronically, backup files must be prepared to eliminate the possibility that the data may inadvertently be lost. When it begins to become evident that a medium on which data are stored, such as a particular type of magnetic disk or tape, is in danger of becoming obsolete, and there is thus a danger that the data will become irretrievable, all data should be copied to a better medium.

Whenever data are to be transferred or stored, an appropriate control procedure should be established to minimize the danger that human error7*p2120Xwill compromise the quality of the data. Data that are stored in hard, paper copies should be stored in the project files.

Quality Assurance Procedures
Omega Environmental Services

STATE-LEAD PROGRAM
QUALITY ASSURANCE PROJECT PLAN

for
Petroleum Contaminated Sites

Prepared for:

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1.0 QUALITY ASSURANCE PROJECT PLAN

1.1 INTRODUCTION

At the request of the Virginia Department of Environmental Quality (DEQ), Omega has prepared this Quality Assurance Project Plan (QAPP). The QAPP is required because large quantities of environmental samples (e.g., subsurface soil, groundwater, waste, etc) will be collected during State-Lead field investigations. The primary purpose of this Quality Assurance Project Plan (QAPP) is to state the objectives of the investigation with regard to data quality. Specifically, this QAPP will address

- Data Quality Objectives;
- Project management and responsibilities of key Omega personnel;
- Sample collection procedures;
- Staff training in sample collection and equipment calibration and maintenance;
- Quality Control sampling;
- Sample custody;
- Documentation requirements (e.g., field notes, chain-of-custody, analytical results, etc.);
- Data reduction and validation; and
- Corrective actions to address variances to data quality objectives.

Components of the QAPP are discussed in the following sections and subsections.

1.2 DATA QUALITY OBJECTIVES

The U.S. Environmental Protection Agency (EPA) has devised a framework for making decisions concerning a site following evaluation of background, field, and laboratory data. The Data Quality Objective (DQO) process is a quality management tool based on the Scientific Method to facilitate the planning of environmental collection activities. The DQO process will enable Omega to focus planning efforts by specifying the use of data (the decision), the decision criteria (action levels), and the decision maker's acceptable error rates. The product of the DQO Process are the DQOs (EPA, 1993).

DQOs are qualitative and quantitative statements derived from the outputs of each step of the DQO Process. They specify the

- Study objectives;
- Domain, limitations, and the most appropriate type of data to collect;
- Most appropriate conditions under which data is collected; and
- Levels of decision error (uncertainty) that will be acceptable when making decisions.

DQOs specify data type, quantity, and uses needed to make decisions and serve as the basis for designing data collection activities. They are site-specific and are expressed in terms of precision, accuracy, completeness, representativeness, and comparability. Data collected during State-Lead investigations will be used for

- Health and safety monitoring;
- Field screening to assess for the presence of vapor phase organic contaminants;
- Site characterization and if appropriate, preliminary evaluation of remedial alternatives; and
- Risk assessment.

Record keeping, field activities, sampling, sample custody, laboratory analyses, and data reduction and validation will be of sufficient scope and detail and taken with sufficient care so that data generated during State-Lead investigations will be legally defensible. DQOs will be prepared following review of procedures outlined in this QAPP. This QAPP specifies general requirements for collecting data during State-Lead investigations so that conditions, which jeopardize data quality, do not arise.

Geologic and hydrogeologic data will be obtained during borehole advancement and installation of groundwater monitoring wells. The data will be compiled during State-Lead investigations to satisfy project-specific DQOs. The DQOs for each type of hydrogeologic measurement will determine the type of equipment and the relative accuracy and precision required. Hydrologic data collected during State-Lead investigations will consist of water level measurements obtained during monitoring well installation, development, pre-sample purging, and fit specific time intervals.

The following paragraphs briefly describe how data collected during State-Lead field investigations will be evaluated in terms of precision, accuracy, representativeness, comparability, and completeness.

Precision may be evaluated by analyzing matrix spikes, field duplicate samples, determining the Relative Percent Difference (RPD), and comparing the RPD with acceptance criteria presented in this QAPP.

True values for field parameters (e.g., pH, electrical conductance, and groundwater temperature) are not known for specific sampling locations. As such, the accuracy of water quality parameter screening data recorded by field instruments will be maintained and documented by performing proper instrument calibration and maintenance according to manufacturer's instructions.

Procedures presented in this QAPP address issues such as collecting subsurface soil and groundwater samples, screening water samples for pH, temperature, and electrical conductance during monitoring well development and purging, and using dedicated and disposable sampling devices when possible. In addition, representativeness of specific analyses will be achieved by the following means:

- Selecting appropriate number of samples and locations to adequately characterize current site conditions at State-Lead sites;
- Using appropriate sampling equipment and analytical procedures;
- Collecting a sufficient number of field quality control (QC) samples to statistically verify proper functioning of field and analytical procedures;
- Documenting sampling activities and sample locations in field log books, field forms, and chain-of-custody forms that are signed and dated by responsible Omega personnel; and
- Using appropriate techniques to decontaminate field and sampling equipment.

To establish data set comparability, Omega and/or the analytical laboratory will

- Operate field instruments within their calibrated range;
- Participate in performance audits, if requested;
- Use traceable standards in the laboratory; and
- Report field and laboratory data in conventional and standard units.

This QAPP describes field procedures for completeness of field collected samples. Field QC samples including trip blanks, equipment blanks, ambient blanks, source blanks, and field duplicates may be collected during State-Lead investigations to verify that sampling and decontamination procedures are not inadvertently introducing extraneous contaminants. In addition to field QC samples, geologic data generated during State-Lead field investigations will also be reviewed for completeness. For example, logged subsurface soil samples may be described using the

- Unified Soil Classification System (ASTM Standard D-2488-90);
- Munsell Color Charts; and
- Standard geologic descriptions (e.g., grain size and distribution, plasticity, angularity, organic content, etc.).

Standard field forms will be used to document borehole advancement, well installation, and sampling activities. These forms will be reviewed to evaluate comparability of the data collected. Additional geologic and hydrogeologic data obtained during intrusive activities that may be used to satisfy project DQOs will be documented on standardized forms prepared for a specific activity (e.g., monitoring well development, purging, aquifer testing).

2.0 PROJECT MANAGEMENT AND RESPONSIBILITIES

Omega Environmental Services (Omega) consists of highly qualified professionals with expertise in project management, quality assurance/quality control (QA/QC), environmental engineering, environmental science, field investigations, geology, hydrogeology, data management, risk and remediation assessment, and computer aided drafting and design. Responsibilities for key Omega personnel are described below.

2.1 STATE-LEAD CONTRACTOR PROGRAM MANAGER

Mr. David Haney will serve as the State-Lead Contractor Program Manager. He will report to Mr. Scott Harper. Both are employed at Omega's office in Richmond, Virginia. Mr. Haney will have primary responsibility for all project management matters that affect the State-Lead contract. The Program Manager will be responsible for all aspects of the day-to-day operation of the State-Lead contract. These responsibilities will include:

- Contract administration;
- Personnel scheduling;
- Budget tracking and control;
- Client relations;
- Technical direction;
- Final review of State-Lead deliverables;
- Overall project QC; and
- Production scheduling.

To complete these efforts, Mr. Haney will work directly with Omega Project Managers to:

- Develop and implement work task responsibilities and strategies;
- Select State-Lead project team members;
- Assign responsibilities to project team members;
- Schedule and coordinate staff meetings;
- Maintain open lines of communication with Virginia DEQ State-Lead personnel; and
- Attend contract and progress meetings with Virginia DEQ State-Lead personnel as required.

2.2 STATE-LEAD CONTRACTOR PROJECT MANAGER

Omega currently employs certified professional geologists, degreed geologists, and degreed environmental engineers as State-Lead Project Managers. Omega Project Managers are employed in Omega's Richmond, Virginia, Woodbridge, Virginia, and Greensboro, North Carolina offices. Project Managers will report directly to Mr. Haney and interface regularly with Virginia DEQ Regional State-Lead Project Managers as necessary to complete work assignments. Principal responsibilities of the Project Manager will include:

- Conducting an initial visit to evaluate general site and environmental conditions;

- Developing the technical scope of work (SOW) and preparing a cost estimate using the Virginia DEQ State-Lead Activity Authorization Form;
- Securing site access from the responsible party (RP) and necessary permits from regulatory agencies;
- Preparing investigative reports involving initial abatement, site characterization, remediation/corrective action, alternate water supply development, and site closure;
- Preparing Site-Specific Health and Safety Plans;
- Geologic, hydrogeologic, and contaminant modeling;
- Peer reviewing State-Lead deliverables;
- Planning fieldwork;
- Equipment specification, engineering design, and selection;
- Providing on-site direction, coordination, and management in completion of State-Lead field investigations;
- Supervising the work of lower level professionals;
- Serving as primary liaison between RP and Virginia DEQ; and
- Coordinating work with Virginia DEQ, the RP, and project subcontractors.

2.3 CORPORATE QUALITY ASSURANCE/QUALITY CONTROL MANAGER

Omega's corporate QA/QC Manager, Mr. Charles D. Markun, P.G., works at the Lakeland, Florida corporate office. Mr. Markun will be responsible for all State-Lead related QA issues. This may include

- Reviewing deliverables;
- Performing field and laboratory audits; and
- Assessing corrective action procedures to ensure that project activities meet data quality objectives (DQOs).

2.4 HEALTH AND SAFETY MANAGER AND OFFICER

The Omega Project Manager or their designee will prepare a Site-Specific Health and Safety Plan (HSP) for all field investigations performed under the auspices of the State-Lead Program. Mr. Rick Antes will serve as Omega's Corporate Health and Safety Officer with regard to the State-Lead Program. Mr. Antes works at Omega's Lakeland corporate headquarters. He will ensure that all field activities are performed according to approved HSP and the provisions set forth in the Occupational Health and Safety Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910.120 for worker health and safety. Mr. Antes will provide assistance, oversight, and senior review of the HSP. The HSP Manager or their designee may perform audits to ensure that fieldwork is performed according to the tasks outlined in the HSP.

The Omega Health and Safety Officer will be the on-site supervisory geologist or engineer. They will be responsible for ensuring that health and safety protocols outlined in the HSP are implemented by Omega field personnel and project subcontractors. During State-Lead field investigations and corrective actions, the Health and Safety Officer will

- Conduct a brief tailgate safety meeting with all field personnel to discuss existing and/or potential site hazards before field activities begin;
- Visually assess the safety of the drill rig and/or any other field equipment (e.g., backhoes, mobile remediation system trailers) prior to initiating field activities;
- Monitor the ambient air in the vicinity of on-site workers; and
- Be responsible for personnel protection.

The Omega Health and Safety Officer will document all accidents and injuries that may occur during field activities. They will have the authority to stop all work if it is deemed necessary to protect field personnel.

2.5 STAFF SCIENTISTS AND ENGINEERS

Staff scientists and engineers will work under the supervision of Omega's State Lead Program Manager and Project Managers. Their principal responsibilities may include

- Fieldwork preparation and implementation;
- Prepare cost estimates for project sub-tasks;
- Overseeing soil boring and monitoring well installation;
- Aquifer testing;
- Supervise UST removal, soil removal, and other on-site remediation activities;
- Remediation system pilot testing and implementation;
- Prepare field notes.
- Limited data review and analysis; and
- Report preparation under supervision of Project/Program Managers.

2.6 TECHNICIANS

Omega technicians will be used primarily on State-Lead projects to conduct fieldwork. They will work under the direct supervision of Omega Project Managers and/or staff scientists or engineers. Typical responsibilities will include:

- Field work preparation;
- Operation and maintenance of machinery and field equipment;
- Mobilization and demobilization of field equipment;
- Well development, purging, and groundwater sampling;
- Waste handling;
- Remediation system installation;
- UST system excavation and removal;
- Site restoration;
- Maintain field/sampling logs and equipment maintenance records.

2.7 CADD AND CLERICAL

Clerical and computer aided drafting and design (CADD) operators will be used on State-Lead projects to help prepare deliverables. They will report directly to the Omega Project Manager. The CADD operators will generate maps such as groundwater contour maps, isoconcentration maps, and geologic-cross-sections. Clerical staff will be responsible for document reproduction, filing, mailing, and general secretarial duties.

2.8 PROJECT SUBCONTRACTORS

Qualified subcontractors will conduct a portion of State-Lead field investigations. To ensure that all subcontractor activities are planned and completed according to the project-specific SOW, the Omega Project Manager will maintain regular contact with project subcontractors. The Omega Project Manager will be responsible for

- Communicating periodically with project subcontractors;
- Coordinating and overseeing their work activities;
- Monitoring subcontractor compliance with the project-specific SOW during all phases of the work;
- Addressing subcontractor concerns;
- Resolving potential problems and contractual difficulties.

Project subcontractors that may be retained on State-Lead investigations include

- Drillers;
- An off-site analytical laboratory;
- Land surveyors; and
- Geophysicists;

The responsibilities of the various project subcontractors are discussed briefly in the following subsections.

2.8.1 Drilling Services

A qualified drilling subcontractor will be used to advance soil and bedrock borings, collect subsurface soil and rock chip or core samples and install groundwater monitoring wells. The retained drilling contractor will possess a current Commonwealth of Virginia contractor's license, and have completed the 40-hour OSHA health and safety training course along with the 8-hour annual refresher. Borings will be advanced through overburden with a truck-or track-mounted drill rig using continuous flight hollow stem augers. If the boring must be advanced into the underlying bedrock, air rotary drilling techniques will be used. Undisturbed, discrete, and representative subsurface soil samples will be collected from the borehole at approximately 5-foot intervals with a 2-inch diameter split-spoon sampler, driven in accordance with ASTM Standard D-1586-84 (Test Method for Penetration Test and Split-Barrel Sampling of Soils). Monitoring wells will be installed using rigid polyvinyl chloride (PVC) well screen and casing and constructed according to the general procedures outlined in ASTM Standard 5092-90 (Practice for Design and Installation of

Groundwater Monitoring Wells in Aquifers). The drilling contractor will observe all health and safety procedures outlined in the HSP and properly decontaminate all drilling and sampling equipment that enters the borehole.

2.8.2 Off-Site Analytical Laboratory

Omega shall retain a Commonwealth of Virginia certified laboratory to analyze soil, groundwater, and air samples. The analytical laboratory will also perform QA according to Commonwealth of Virginia and U.S. Environmental Protection Agency (EPA) approved methods.

2.8.3 Surveying Services

During most State-Lead field investigations, Omega personnel will survey in the location of prominent site features and groundwater monitoring wells. However, if the site exhibits complex conditions or the investigation involves evaluation of adjoining properties, Omega may retain the services of a Virginia licensed surveyor. The land surveyor will

- Conduct a record search to determine property boundaries and easements prior to performing the field survey;
- Prepare a metes and bounds description and plat;
- Locate all off-site drilling easements as described in recorded data;
- Determine the elevations and coordinates of all soil/bedrock borings, groundwater monitoring wells, buildings, accessways, and other prominent site features; and
- Submit paper copies of the survey along with computer files on AutoCAD.

2.4.4 Geophysical Services

Omega may retain a qualified contractor(s) to conduct borehole and/or surface geophysical surveys. Borehole geophysical surveys will be conducted to:

- Identify fracture zones;
- Characterize fracture density, distribution, orientation, and type;
- Identify lithology, structure; and rock textures; and
- Confirm findings of the rock drilling program.

Surface geophysical surveys may be conducted to

- Locate subsurface utilities, piping, and buried drums and USTs;
- Define geologic features such as faults, water-bearing fracture zones, karst bedrock, and bedrock topography;
- Estimate depth to groundwater and overburden thickness; and
- Map relative conductivity of an area of potential soil and groundwater contamination.

Figure 1 presents a State-Lead organizational chart that identifies key Omega personnel.

Insert Figure 1 – State-Lead Project Organizational Chart

3.0 SAMPLE COLLECTION

3.1 STANDARD SAMPLE COLLECTION PROCEDURES

3.1.1 Groundwater

Groundwater samples shall be collected from properly constructed monitoring wells in order of ascending contamination to minimize the potential for cross-contamination of wells. Prior to sampling, monitoring wells will be properly developed and purged. All sampling activities will be recorded in a field logbook.

Before groundwater sampling begins, monitoring wells shall be visually examined for signs of tampering or other damage. If tampering is suspected (e.g., casing damaged, lock or cap missing), this information will be recorded in the field logbook and reported to the Omega Project Manager. The Omega Project Manager will assess whether the reported damage or tampering warrants whether the monitoring well is sampled.

Before the start of sampling activities, visible water that has collected in the above ground protective casing or flush-mounted manhole cover will be removed prior to venting and purging. Each time a well casing cap is removed to measure groundwater levels or to collect a groundwater sample, the ambient air in the breathing zone may be checked with either a photo ionization detector (PID) or flame ionization detector (FID). PID or FID measurements will be reviewed to evaluate the potential for fire, explosion, safety hazards, or other threats to the health of on-site workers. Similarly, air in the well bore may be screened for organic vapors with a PID/FID and for explosive gases with an explosimeter, if warranted.

Sampling equipment will be equipped with a positive foot check valve to prevent purged water from flowing back into the monitoring well. Purging and sampling will be performed in a manner that minimizes aeration in the well bore and agitation of sediments in the monitoring well and adjacent formation. Omega anticipates the use of single use plastic bailers, dedicated PVC bailers, or low-flow submersible pumps to purge and collect groundwater samples from the monitoring wells. If a submersible pump is used to collect groundwater samples, the samples shall be collected from the discharge line of the pump after the flow is steady and no air bubbles can be observed.

The following information will be recorded in a field log book each time a monitoring well is purged and sampled:

- Depth to static groundwater before purging;
- Well bore volume calculation;
- Sounded total depth of the monitoring well;
- The physical condition of each well;
- The apparent thickness of any LNAPL or DNAPL layer encountered; and
- Field parameters, such as pH, temperature, electric conductance (EC), oxidation/reduction potential (ORP), alkalinity, dissolved oxygen, and turbidity.

Groundwater samples will be sampled no sooner than 24 hours following monitoring well development. Samples will be collected from shallow overburden monitoring wells using either a submersible pump or bailer. Deep bedrock monitoring wells will be sampled using a low-flow submersible pump. Pumps that exert a vacuum on the sample (e.g., centrifugal pumps) will not be used.

Samples shall be collected after a minimum of three well bore volumes of groundwater has been purged from the monitoring well. Alternatively, purging will continue until water stabilization parameters (e.g., temperature, pH/ORP, EC, DO, and turbidity) stabilize. Stabilization will be defined as follows: +/- 1oC, pH +/- 0.1 units, and EC +/- 5 percent. If these parameters have not stabilized, the sample will be collected after six well bore volumes have been removed. All groundwater samples submitted for laboratory analysis of petroleum constituents will be collected within 48 hours after initiating pre-sample purging.

3.1.2 Subsurface Soil

During State-Lead mandated field investigations, Omega will collect at least one discrete, undisturbed, and representative subsurface soil samples from each boring. Subsurface soil samples will be collected for lithologic information, field headspace screening for the presence of vapor phase petroleum hydrocarbons, and laboratory analysis of petroleum constituents. Samples submitted for laboratory analysis will be selected on the basis of odors, discoloration or staining, FID/PID results, and other field observations. Additional subsurface soil samples may be submitted to support groundwater modeling efforts and evaluation of remedial alternatives.

Subsurface soil samples will be collected with a 2-inch diameter split-spoon sampler driven in accordance with ASTM Standard D-1586-84 "Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils." The subsurface soil sample will be obtained by driving the sampler 2 feet into undisturbed soil with a 140-pound hammer free falling approximately 30 inches. The number of hammer blows are then recorded for each 6 inches of penetration (i.e., 5/7/9/12). The standard penetration test result (N) is obtained by adding the middle two blow counts to estimate soil density.

After opening the split-spoon sampler, an appropriate sample container will be filled completely with a representative portion of the soil sample to minimize volatilization.

3.1.3 Soil Vapor

After collecting the split-spoon soil sample, the relative soil vapor concentration will be recorded using a portable FID or PID. Soil vapor concentrations are recorded to qualitatively assess the presence of vapor phase petroleum hydrocarbons. Soil samples obtained from the borings will be screened in the field by filling a self-closing polyethylene plastic bag half full with approximately 250 grams of soil. The soil samples will then be vigorously shaken for approximately 30 seconds and allowed to equilibrate a minimum of 15 minutes and a maximum of 2 hours to a temperature of 25°C. The bag headspace will then be determined by partially opening the self-closing seal, inserting the FID/PID probe to a distance approximately one-half the headspace depth, and recording the highest reading displayed on the instrument meter. The results of field headspace

screening will be recorded on the soil boring log and used to select samples from each boring for laboratory analysis of selected petroleum constituents.

3.1.4 Other

3.1.4.1 Potable Water Supplies

Potable water supplies may be sampled during the Alternate Water Supply phase of a State-Lead investigation. When Omega collects discrete and representative groundwater samples from potable wells, the wells are purged prior to collecting the sample. Purging ensures that groundwater representative of the formation is sampled, not standing water stored in the well casing, production pipe, or holding tank. As a rule of thumb, at least one volume of groundwater in the well casing and storage tank is purged. For most residential potable wells, this typically corresponds to a 15-minute period.

Groundwater samples are usually not collected directly from the wellhead because sampling equipment may become entangled with production pipes, electric lines, and/or the submersible pump. As such, potable water supply samples are typically collected from an indoor or outdoor tap (faucet). Omega visually examines the sample tap to ensure that it is supplied with water from a service pipe connected directly to a water main in the segment of interest. The tap is also observed to see if it is susceptible to exterior contamination by being too close to the ground or sink bottom. Before sampling, Omega field personnel will remove the aerator or strainer before sampling. These devices can harbor bacteria if they are not routinely cleaned or replaced when worn or cracked. Omega field personnel will also avoid collecting groundwater samples from cold water taps that leak, allowing water to flow out from the stem of the valve handle and down the outside of the tap, and taps that do not elicit a steady stream of water.

Field personnel will don gloves with collecting groundwater samples from the sample tap. Regardless of the type of sample bottle used, the bottle cap will not be placed on the ground or in a pocket. In addition, Omega field personnel will not permit the faucet to contact the inside of the bottle during sampling. When sampling for bacterial content, the sample bottle will not be rinsed out before use. Finally, care will be exercised to ensure that splashes of water from the ground or sink do not enter either the sample bottle or cap.

3.1.4.2 Surface Soil

If requested, Omega will collect surface soil samples to support baseline risk assessment studies. Stainless steel scoops, trowels, or disposable plastic scoops will be use for surface soil samples obtained from 0-6 inches below ground surface. Samples collected from approximate depths of 6-24 inches below ground surface (or refusal) will be collected with a decontaminated hand auger, hand-operated split-spoon sampler, or standard hollow stem split-spoon sampler.

The hand auger or split-spoon sampler will be pulled from the boring and the cuttings deposited on plastic sheeting or in a container. Hand augering or split-spoon sampling will continue until the desired sampling depth is achieved. After describing sample lithology, the recovered surface soil sample will be composited in a stainless steel bowl and homogenized by thoroughly mixing with a

stainless steel spoon. The homogenized soil will be divided into four equal quarters with the composited soil collected from one of the quarters and placed in appropriate sample containers. The sampling equipment will be decontaminated prior to advancing a new borehole to minimize potential for cross-contamination.

Gravel, rock, and vegetation will be excluded from surface soil samples. Samples will be collected as quickly as possible to minimize loss of organics. During field sampling activities, Omega will record surface conditions that may affect chemical analysis. These conditions may include

- Approximate distance to roadways and access roads;
- Obvious deposition of contaminated or clean soil at the site;
- Evidence of dumping or spillage of contaminants; and
- Soil discoloration, unusual condition of growing plants, and stressed vegetation.

3.1.4.3 Surface Water

If known or suspected source areas are located upgradient of nearby surface water bodies, it may be necessary to collect surface water samples. To minimize the potential for cross-contamination between location and media, surface water samples will be obtained prior to collecting stream sediment samples. The surface water sample that is farthest downstream will be collected first. Prior to collecting surface water samples, Omega personnel will traverse the stream and note the location of any seeps, oily sheens, or discolored soil horizons.

Surface water samples will be collected using a pond sampler or other suitable sampling device. Whenever possible, Omega field personnel will obtain the surface water samples during or following periods of precipitation. Because of safety concerns, surface water sampling will be restricted to daylight hours. If water samples are collected from a seep or spring, the sample will be obtained by submerging a stainless steel, Teflon, or glass container directly under the surface water discharge point.

At each surface water sampling location, a permanent marker (flagged stake in stream bank) will be placed at the site of each surface water sample. Omega field personnel will record the following observations:

- Approximate stream width, depth, and flow rate;
- Color;
- Odor;
- Presence of oily sheens or free product;
- Status (e.g., clean, oil, bubbles, suspended solids, other);
- Presence of discharge pipes or tributaries; and
- Water stabilization parameters.

Surface water samples will be submitted to the laboratory unfiltered, except for lead, which will be submitted filtered and unfiltered.

3.1.4.4 Sediment Sampling

A potentially more reliable indicator of surface water contamination is the underlying stream sediments. Unlike surface water contaminants, which may become diluted or chemically transformed downstream, contaminants have a tendency to accumulate in sediments.

If possible, sediment samples will be collected from depositional areas. As indicated above, sediment samples will be collected after surface water samples. The order of stream sediment sampling will begin with the farthest downgradient sample and move progressively upgradient to minimize the potential for cross-contamination between locations and media. Where appropriate, stream sediment samples will be collected from the active streambed on the stream side nearest the contamination source. During surface water and stream sediment sampling, Omega field personnel will place a permanent marker (flagged stake in stream bank) at the location of each sample point. They will also sketch the sample locations and record the following field observations in a field logbook:

- Sediment type (e.g., sand, silt, gravel, clay, organic, other);
- The percent recovery, if sediment cores are collected;
- Geomorphology (channel shape, stream bank description, erosional/depositional characteristics);
- Vegetation type;
- Color and/or discoloration;
- Sample depth;
- Odor;
- The sampling device.

Sediment samples will be collected for laboratory analysis using one of the following devices:

- Hand Auger;
- Hand Corer; or
- Pond Dredge.

A hand auger will be used to collect sediment samples if the substrate is hard and otherwise difficult to sample. The hand corer collects an undisturbed sediment sample. A pond dredge can be used to collect sediment samples from flowing streams.

3.1.4.5 Direct Push Sampling

Omega possesses a *Hurricane*™Model 2600 Sampler to conduct direct push sampling. Direct push sampling is performed using a vehicle-mounted, hydraulically powered soil probing machine. It uses static force and percussion to advance small diameter sampling tools into the subsurface for collecting soil core, soil gas, and/or groundwater samples. The advantages of direct push technology over hollow-stem auger sampling include

- Minimal disturbance to surface and sampling media;
- Minimal generation of investigative-derived waste;

- Lower disposal costs;
- Maneuverability in tight spaces;
- Reduced mobilization time and cost;
- Ability to operate indoors;
- Vapor, LNAPL, and/or groundwater sampling without permanent well installation; and
- Placement of permanent monitoring/air sparging points.

Omega conducts direct push sampling using a specified grid so that the vertical and lateral extent of contamination can be delineated. The soil sampler is attached to the lead probe rod and driven into the subsurface using the Hurricane. Additional probe rods are connected in succession to advance the sampler to its desired depth. To recover the sample, the sampler is retrieved from the probe rod assembly and the plastic, thin-walled plastic tube (liner) is removed. To retrieve the soil from the liner, the soil is extruded from the liner or the liner is cut longitudinally to remove the soil.

To collect undisturbed and representative groundwater samples, a sealed stainless steel screen inside a perforated stainless steel sleeve is pushed out into the direct push borehole. After installing the temporary well screen, groundwater is allowed to enter the sampler and connected probe rods. Alternately, groundwater samples are recovered by pumping water collected in the open probe rods. Finally, groundwater samples are collected by pumping groundwater through plastic tubing that extends from the surface to the sampler well screen.

3.1.4.6 Air Sampling

During remediation system pilot testing, Omega field personnel routinely collect samples to assess the air discharge concentrations of selected petroleum constituents (e.g., BTEX, MTBE, and TPH/GRO) that may enter the atmosphere. The following procedures are used to collect air samples:

- Record air velocity readings with a hand-held Anemometer, a portable Magnehelic™ pressure air velocity gauge with a pitot tube, a DS Flow Sensor with a Capsuhelic™ differential pressure gauge, or an existing permanent mounted air flow meter (rotameter).

- Connect a 1-liter Tedlar™ bag to the air sampling port through plastic tubing extending from a sample port located on the discharge side of the pump stack extending out of the seal water tank.

- Fill the Tedlar bag completely;

- Close the air valve on the tedlar bag and remove it from the sample port.

- Open the air valve on the tedlar bag so that a PID or FID reading can be recorded. Record the reading on the Operation and Maintenance Checklist form, in the system operation field book, and in the Omega field personnel log book.

- Disconnect the PID or FID from the Tedlar bag.

- Reconnect the air bag to the sample port and fill the bag completely.
- The following information will be recorded on the sample label for the air sample:

    - Sample location;
    - Date and time of collection;
    - Omega State-Lead job name and number;
    - Sampler(s) name(s); and
    - Analyses requested.

After collection, Omega field personnel will place air samples in a box and/or cooler and store in a dark place out of direct sunlight or artificial light. Alternatively, air samples will be collected using black 1-liter Tedlar™ bags.

3.1.4.7 Investigative-Derived Waste Disposal and Sampling

Field investigations at petroleum contaminated sites may generate investigative-derived waste (IDW). The types of IDW generated at petroleum impacted site include

- Personnel protective equipment (PPE)– disposable coveralls, gloves, booties, respirator cartridges, splash suits;

- Disposable equipment (DE)– plastic ground and equipment cover, single use plastic bailers, tubing, broken and/or unused sample containers, sample container boxes, tape, etc;

- Soil cuttings generated during drilling operations or excavation and removal of UST systems;

- Drilling mud or water used during rotary drilling operations;

- Groundwater containerized for well development and/or purging; and

- Decontamination fluids

Unless light non-aqueous phase liquids are encountered in the monitoring wells during well development and pre-sample purging, Omega field personnel will discharge removed groundwater directly to the ground surface. Provided there is a sufficient cover of grass, well development and purged groundwater will be discharged downgradient of the monitoring well but within the confines of the site contaminant plume. If the site is mantled with gravel or asphalt, well development and pre-sample purge water may be collected in 55-gallon capacity DOT-approved drums.

Drilling operations in overburden may generate a significant quantity of soil cuttings. If field headspace screening results and visual evidence suggest these soils are relatively uncontaminated, Omega field personnel will spread soil cuttings in a thin layer in the vicinity of the borehole. However, if field screening, olfactory, and visual evidence suggest these soils are highly contaminated, Omega will temporarily stockpile and secure cuttings or excavated soil on plastic sheeting. A composite soil sample will then be collected from the stockpile to determine if the

stockpiled soil requires disposal or remediation at a licensed off-site facility. If a composite soil sample is collected, the following sample methodology will be implemented:

- Collect a minimum of six individual soil samples (approximately 250 grams) from the soil stockpile;
- Composite the soil in a stainless steel bowl;
- Homogenize the composited sample with a decontaminated stainless steel spoon;
- Split the homogenized soil into four quarters;
- Collect one of the quarters for laboratory analysis of selected petroleum constituents.

PPE and DE IDW will be bagged, compacted if necessary, and transported off site for disposal. These IDW may be disposed of at a municipal dumpster, trash containers, or taken to a locally permitted landfill.

3.1.4.8 Quality Assurance/Quality Control (QA/QC) Sampling

At State-Lead sites with numerous sampling locations, Omega may recommend implementing a field QA/QC sampling program to ensure that sampling and analytical procedures are properly executed. It should also be implemented to identify and correct errors in the project database that could result in erroneous decisions being made regarding a State-Lead site. The number of field QC samples collected will be determined following consultation with the Regional State-Lead Project Manager and based on data quality objectives for the proposed scope of work. Field QC samples that may be collected during a State-Lead investigation include

- Trip blanks;
- Equipment blanks;
- Ambient blanks;
- Source blanks; and
- Field duplicates.

The methodologies to collect field QC samples are discussed in the following subsections.

3.1.4.8.1 Trip Blanks

Trip blanks consists of a 40 milliliter (ml) sample vial filled at the laboratory with reagent-free water. The blank is transported to the sampling site in an insulated cooler with empty precleaned sample containers, handled like an environmental sample, and returned to the laboratory for analysis. Trip blanks are not opened in the field. They are prepared only when VOC samples are collected and are analyzed only for VOC analytes such as BTEX, MTBE, and TPH. Trip blanks are collected to assess potential extraneous introduction of contaminants from sample containers or during transport or storage of samples.

3.1.4.8.2 Equipment Blanks

When groundwater samples are collected at a State-Lead site, equipment blanks may be collected immediately following equipment decontamination. They consist of a sample of deionized water

that is poured into, over, or pumped through a decontaminated, non-dedicated sampling device (e.g., pumps, split-spoon sampler, hand auger). Specifically, deionized water is poured or pumped through over the cleaned surfaces of the sampling device that contact sample media. Equipment blanks are collected in appropriate precleaned sample containers, labeled, placed in an insulated cooler with other filled sample containers, and submitted to the analytical laboratory. At the laboratory, the equipment blank is analyzed for all parameters requested for the groundwater sample. Laboratory data for the equipment blank sample(s) is reviewed to assess the effectiveness of equipment decontamination procedures.

3.1.4.8.3 Ambient Blanks

Ambient blanks are collected to assess whether ambient sources (e.g., active runways, auto exhaust, dust, precipitation) are being introduced to the samples during collection. Omega recommends collecting an ambient blank sample during each sampling round if a possible local VOC source is identified. If identified, ambient blanks should be collected downwind of the identified VOC source.

The ambient blank consists of reagent-free water that is poured into a 40-ml sample vial at the sampling site. It will be handled like an environmental sample and transported to the laboratory for analysis. Ambient blanks are prepared only when VOC samples are taken and are analyzed only for VOC analytes.

3.1.4.8.4 Source Blanks

During a field investigation, substantial quantities of potable water may be necessary to continue drilling operations. For example, potable water may be needed during rock drilling operations to cool the diamond drill bit, increase hydrostatic pressure for the purpose of enhancing borehole stability, or decontaminate drilling and sampling equipment. To address this concern, a cost-effective and practical approach is to tap into a local public water supply or upgradient site or off-site private drinking water well. To ensure that contaminants are not being introduced into the borehole from an off-site source, a source blank should be collected prior to initiating field activities and submitted for laboratory analysis. The source blank should be handled like all groundwater samples and analyzed for all parameters requested for the groundwater sample.

3.1.4.8.5 Field Duplicates

A field duplicate sample is a second sample collected at the same location as the original sample. Duplicate samples are collected simultaneously or in immediate succession to the original sample. They are recovered from the sample location using identical recovery techniques, and are handled in an identical manner during storage, transportation, and analysis. The sample containers will be assigned an identification number in the field that cannot be identified (blind duplicate) as duplicate samples by laboratory personnel performing the analysis. Specific locations will be designated for collection of field duplicate samples prior to initiating sample collection.

Duplicate sample laboratory results are reviewed to assess the analytical precision of the laboratory.

3.1.5 Staff Training in Sample Collection

All Omega personnel involved in conducting State-Lead field investigations have successfully completed a 40-hour OSHA health and safety training course. In addition, they are required to attend an annual 8-hour health and safety refresher course and undergo annual medical monitoring to evaluate potential exposure to organic contaminants. Finally, several senior Omega personnel have also completed the 8-hour OSHA supervisory level health and safety training course.

Omega field personnel receive extensive training in sample collection from senior staff. Training is received in the field and augmented by review of Omega's standard operating procedures (SOPs) that address sample collection techniques. SOPs that address field investigation activities, including sample collection include:

- Well Gauging;
- Soil Sampling;
- Soil Classification;
- Monitoring Well Gauging;
- Monitoring Well Sampling;
- Slug Testing;
- Monitoring Well Abandonment;
- Elevation Survey;
- Field Log Books; and
- Remediation System O&M, Monitoring, and Pilot Testing.

Omega maintains a wide variety of field equipment used to collect representative samples and complete State-Lead investigations. They are listed on Table .1

Table 1: Summary of Field Instruments

General Use	Item	Quantity	Model Number
[illegible]	[illegible]	[illegible]	[illegible]
	Solinst Interface Meter	4	122
[illegible]	[illegible]	[illegible]	[illegible]
	ART Oil/Water Interface Probe	1	15101-E
[illegible]	[illegible]	[illegible]	[illegible]
Gas Detectors	Sensidyne Gas Meter	1	41085C
[illegible]	[illegible]	[illegible]	[illegible]
	Foxboro Century OVA	2	128
[illegible]	[illegible]	[illegible]	[illegible]

Table [illegible] Summary of Field Instruments (Continued)			
General Use	**Item**	**Quantity**	**Model Number**
Gas Detectors	Healthtec Porta-FID	1	--------
[illegible]	[illegible]	[illegible]	[illegible]
	MSA Passport Personal Alarm Meter	1	--------
[illegible]	[illegible]	[illegible]	[illegible]
	Schonstedt Magnetic and Cable Locator	1	MAC-51B Receiver
[illegible]	[illegible]	[illegible]	[illegible]
	Grunfos™ MP1 0.5 hp Pump	2	1A106003
[illegible]	[illegible]	[illegible]	[illegible]
	Accuwell 150 Portable 12-volt Pump	1	--------
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
	David White Sight Level	1	LP6-201
[illegible]	[illegible]	[illegible]	[illegible]
	David White Auto Level-Transit ALT6-900w/Tripod	1	9060
[illegible]	[illegible]	[illegible]	[illegible]
	Rolatape Measuring Wheel	2	400
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
	Atlantic Fluidics-10 hp	1	A130

General Use	Item	Quantity	Model Number
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
	Hanna HI Dissolved Oxygen Meter	1	9142
[illegible]	[illegible]	[illegible]	[illegible]
	Orion Digital pH Meter	1	210A
[illegible]	[illegible]	[illegible]	[illegible]
	Cole Parmer Digital pH meter	1	59000-00
[illegible]	[illegible]	[illegible]	[illegible]
	ICM Turbidimeter	1	11520

3.1.6 Instrument Inspection, Testing, Calibration, and Maintenance

The following sections discuss equipment calibration and maintenance procedures that will be performed during State-Lead investigations. All field measurements will be obtained according to procedures outlined in equipment operating manuals.

3.1.6.1 Frequency of Calibration

All field equipment will be calibrated daily if they are used that day. Calibration will provide quality assurance checks on all field equipment used to conduct State-Lead mandated field investigations. Each instrument will have an individual identification number. This number will be transcribed on field data records and/or field logbooks when using a particular instrument for a sampling event. All calibration, repair, and service records will be kept in individual equipment logbooks maintained for each type of instrument. Field equipment that consistently fails to meet calibration standards or exceeds manufacturer's critical limits will be promptly repaired or replaced. Omega will record equipment calibration on a calibration log sheet.

3.1.6.2 Calibration Procedures

The following subsections are examples of calibration procedures that may be performed during State-Lead field investigations.

3.1.6.2.1 Portable Flame Ionization Detectors (FIDs)/Photo Ionization Detectors (PIDs)

A portable PID or FID will be calibrated each day prior to initiating daily field activities. For the PID, instrument calibration will be performed using isobutylene calibration gas of known

concentration (100 ppm or 250 ppm). Hydrogen gas of known concentration (100 ppm) is used to calibrate the FID. All adjustments to instrument settings will be recorded in a field logbook.

3.1.6.2.2 Interface Probe

Calibration of the interface probe is performed by checking the infrared and conductivity circuits. The infrared circuit detects the presence of a liquid while the conductivity circuit differentiates between conductive liquid (water) and nonconductive liquid (LNAPL or DNAPL).

To check the infrared circuit, follow these procedures: with both the main and probe switches on, insert the cleaning brush into the base of the probe until it reaches the zero measuring point. The zero measuring point is the juncture between the stainless steel body of the probe and the brown Teflon/Delrin base plug. This cuts the infrared beam and activates a steady tone and two lights.

To check the conductivity circuit, follow these procedures: with both the main and probe switches on, insert the probe into normal tap water as far as the zero measuring point. This causes a single light and intermittent tone to activate.

The interface probe tape is calibrated annually by using a surveyor's steel tape to adjust for stretching of the calibrated line.

3.1.6.2.3 Electrical Conductance, pH, Temperature, Dissolved Oxygen and Turbidity

Water quality stabilization parameter measurements may be recorded at each groundwater sampling location during monitoring well development and pre-sample purging. Instruments used to obtain these measurements will have to be routinely calibrated.

The pH function will be calibrated immediately before well development and purging using at least two buffer solutions that bracket the expected pH.

The electrical conductivity function will be calibrated using two solutions of known values that bracket the expected ranges of conductivities.

The dissolved oxygen function will be calibrated against temperature-compensated, air saturated water.

The calibration of the portable turbidimeter will be calibrated using two supplied standards within the range of anticipated sample turbidities. These standards are carefully manufactured and are guaranteed to be accurate within 1 percent.

3.1.6.3 Equipment Maintenance

Preventative maintenance procedures will be established so those field instruments can perform their intended functions. Field instrument maintenance records will be kept in individual files assigned to each instrument.

3.1.6.3.1 Maintenance Schedules

Omega personnel will perform preventative maintenance for field equipment. Maintenance will routinely precede each sampling event. However, some field instruments may require scheduled and periodic maintenance. More extensive maintenance will be performed according to the manufacturer's instructions on the basis of use. To minimize the occurrence of instrument failure or malfunction, preventative maintenance will be scheduled. Examples of preventative maintenance procedures and schedules for field instruments are described in the following sections.

3.1.6.3.2 pH-Temperature-Electrical Conductance-Oxidation/Reduction-Dissolved Oxygen

Preventative maintenance for portable pH meters primarily involves properly caring for the individual electrodes. Electrodes will be stored in a 1:1 solution of pH 7 buffer and deionized water. Spare parts, such as replacement probes and fresh buffer solutions, will be available at all times. For continuous trouble-free operation of the pH meter and combination pH electrodes, annual factory maintenance is recommended.

3.1.6.3.3 FID/PID

Field maintenance procedures are limited to keeping the PID or FID probe tip and exterior shell clean and the battery charged. Office maintenance includes cleaning the ultraviolet lamp (UV) window with appropriate lens paper, charging the battery overnight, and wiping the exterior of the unit with a damp cloth and mild detergent. At least one backup UV shall be kept in stock along with lamp filters. For continuous trouble-free operation of the FID or PID, annual maintenance is recommended.

3.1.6.3.4 Turbidimeter

Periodic maintenance of the turbidimeter is not required. The sample chamber of the turbidimeter shall be kept dry and clean with compressed gas. The chamber shall be capped except while inserting or removing the sample tube. The lamp shall be tested for stability prior to initiating fieldwork and replaced at the supplier's laboratory if necessary. As a rule, AC power shall be used instead of the battery. If a battery is used, it should be recharged daily.

3.1.6.3.5 Interface Probe

After each use, the tape should be wiped clean, rinsed with distilled water or hexane, and carefully rewound onto the reel. The probe should be cleaned with Alconox, rinsed thoroughly with distilled water, and wiped dry. Clean brushes should be used through the side and base hole to remove remaining product from the inner areas of the probe. The last steps involve scrubbing the bottom pin with steel wool, returning the cleaned probe to the holder, and turning off both switches. If incorrect signals occur, the probe and reel battery should be changed at the same time using 9-volt batteries. Batteries should be replaced after approximately 9-10 hours of use. O-rings shall be lubricated.

3.1.6.3.6 Water Level Indicator Tape

The electronic water level indicator will be cleaned prior to use at each monitoring well location with a soapy cloth, then rinsed with distilled or deionized water. Batteries should be replaced after approximately 9-10 hours of use.

3.1.7 Documentation

Prior to participating in field investigations, new Omega employees will receive detailed hands-on training on the proper use, calibration, and decontamination of field equipment. Training is received from Omega supervisory level personnel with extensive experience conducting site investigations. This training may be received either in the office and/or in the field. Periodically, experienced Omega personnel receive refresher training in the use, decontamination, and calibration of field instruments. Training will be documented and included in the employee's personnel file.

In addition to the use and calibration of field equipment, Omega personnel that participate in intrusive field investigations are required to have successfully completed 40 hours of HAZWOPER health and safety training in accordance with OSHA regulations (40 CFR 1910.120). This training is augmented annually with a HAZWOPER 8-hour refresher course. All Omega field personnel will receive a certificate upon successful completion of health and safety training. Finally, Omega field personnel periodically receive First Aid/CPR training.

4.0 INTERNAL DOCUMENT MANAGEMENT PROCEDURES

4.1 INTRODUCTION

Data collected during State-Lead investigations will be recorded as field notes, laboratory analytical reports, chain-of-custody forms, and field forms documenting sample collection and equipment calibration and maintenance. Copies of these items will be placed in individual project files maintained at Omega's Richmond, Virginia, Woodbridge, Virginia, and Greensboro, North Carolina offices. Upon request, Omega will provide copies of all State-Lead project files to the Virginia DEQ Project Manager.

Field documentation procedures are discussed in the following subsections.

4.2 DOCUMENTATION

4.2.1 Field Notes

Omega shall maintain field records to document sampling and general information about a State-Lead site. Field notes will be recorded during the initial site visit and all subsequent investigation and sampling activities. All entries will be recorded in indelible black or blue ink in a permanently bound field logbook with sequentially numbered pages. Each page of the bound logbook shall record following general information:

- Location and Site Name;
- Date and investigators initials;
- Pollution Complaint Number (PC);
- Weather;
- Identity of individual(s) performing field activities; and
- Weather conditions.

For field measurements, the numerical value and units of each measurement, and the identity of and calibration results of each field instrument will also be recorded on field forms.

The following additional information will be recorded for all sampling activities:

- Sample type and method;
- The identity of each sample and depth(s), where applicable, from which it was collected;
- The amount of each sample;
- Sample description (e.g., color, odor, clarity);
- Identification of sampling devices; and
- Identification of conditions that might affect the representativeness of a sample (e.g., refueling operations, damaged casing).

Records will be kept for all activities associated with field activities as a means to maintain full documentation of project quality assurance/quality control (QA/QC) procedures and compliance.

As indicated above, all documents will be completed in indelible black or blue ink. Errors will be corrected in the field by crossing them out with a single line and then dating them and initialing. The use of correction fluids will not be allowed. Records will be kept in log books and standardized forms developed by Omega. These records will be maintained by Omega in the appropriate State-Lead project file.

4.2.2 Log Book

Omega field personnel will maintain a log book during all State-Lead field investigations. The site log book is the master field investigation document that is a bound book with a hard cover and sequentially numbered pages. The primary objective of the Site Log book is to maintain, within one document, the actual field data or references to other documents that contain a specific description of field activities that has occurred on a given day. Administrative occurrences or activities that have affected the performance of fieldwork will be recorded in the Site Log book.

All field activities entered in the Site Log book will be signed and dated by the on-site supervisory Omega geologist or engineer. The following is a list of the type of information that will be recorded in the Site Log book:

- Physical/environmental conditions encountered during field activity;
- Variances to sample methodologies and QA/QC procedures;
- Name and title of author;
- Date and time(s) of entries;
- Name and titles of field crew;
- Name and titles of all site visitors;
- Documentation of health and safety activities;
- Type of sampled media (e.g., soil, groundwater, etc.);
- Number and volume of samples taken:
- Description of sampling points;
- Date and time of overall sample collection:
- Sample identification numbers;
- General decontamination procedures;
- Instrument calibration;
- Records of telephone conversations; and
- Weather conditions.

4.2.3 Field Data Forms

In addition to the above-referenced log books, Omega will complete standardized field data forms that will record pertinent State-Lead field activities. These include the following:

- Soil Boring Log;
- Monitoring Well Construction Diagrams;
- Monitoring Well Development/Purging Record;
- Monitoring Well Static Water Level Form;

- Field Sampling Report;
- Chain-of-Custody Form;
- Health and Safety Monitoring Sheet; and
- Instrument Calibration Log.

These forms will be maintained in the appropriate project file at Omega's office.

4.2.4 Sample Labeling

After collection, soil and groundwater samples will be transferred to appropriate precleaned sample containers provided by the analytical laboratory. Before filling the sample containers, Omega field personnel will affix sample labels to each sample container. The following information will be marked in indelible ink on the sample label:

- Omega State-Lead Project Number;
- Sample Location;
- Date and time of sampling;
- Sampler(s) name(s); and
- Chemical analyses requested.

After the sample label is affixed and marked, Omega field personnel will wrap clear plastic tape over the sample container and label. Placing plastic tape over the sample label will ensure that it is not compromised during transport to the laboratory.

4.2.5 Chain-of-Custody

Chain-of-custody (COC) forms document the date and time of sample collection and each individual responsible for the disposition of a given sample until analysis is completed. The COC also serves as the analytical request form for the analytical laboratory. It includes both field and laboratory elements that are discussed in the following subsections.

4.2.5.1 Field Custody

After the sample containers have been filled and labeled, Omega personnel will initiate COC protocols in the field. Before placing individual filled sample containers in an insulated cooler with ice or coolant packs, Omega field personnel will complete a COC form provided by the analytical laboratory. The COC form will account for all samples and include the following information:

- Project Name or Number;
- Omega Point of Contact;
- Omega Purchase Order Number;
- Sampler(s) Identification and signature;
- Sample Identification Number:
- Date and Time;
- Number of Containers;

- Matrix (e.g., water, soil, air, sludge, other)
- Type of sample (grab, composite);
- Method of preservation; and
- Analyses requested.

After the COC forms are signed by the appropriate individual(s), the form(s) will be reviewed by Omega field personnel to ensure that all samples are accounted for. If samples must be placed in multiple coolers, a separate COC will be completed for the samples in each cooler. All coolers will be wrapped with packing tape and affixed with custody seals.

If Omega delivers samples directly to the analytical laboratory, the following procedures will be followed:

- When the Omega sampler transports samples, that person will sign the "Relinquished" block on the COC form upon arrival at the analytical laboratory.

- The laboratory custodian receiving the samples will sign the "Received" block on the COC.

- When the samples are transported to the analytical laboratory by someone other than the sampler, the Omega sampler will sign the "Relinquished" block on the COC and the person transporting the samples to the analytical laboratory signs the "Received" block.

- Upon arrival at the analytical laboratory, the transporter will sign the second "Relinquished" block on the COC form and the laboratory custodian accepting the samples will sign the second "Received" block.

If samples are transported to the laboratory through a commercial carrier, Omega will

- Place original COC forms in sealed watertight plastic self-closing (i.e., Zip-Loc™) plastic bags that are taped to the lid of the insulated cooler(s);

- Enter the waybill tracking number on the COC form and in the field log book.

4.2.5.2 Laboratory COC

When the analytical laboratory receives samples, an internal laboratory COC begins and must be maintained. As with field custody, laboratory custody and transfer of samples must be documented so that the identity and integrity of samples can be established and maintained. Laboratory COC procedures will include:

- Verifying field paperwork provided by Omega;
- Logging in samples;
- Assigning laboratory control numbers to samples;
- Verifying refrigerator storage by completing daily temperature verification logs;
- Providing a time chronicle to verify analyte holding times;

- Completing extraction/digestion instrument logs to verify analyses and analytical sequence;
- Preparing a laboratory narrative to document any problems encountered during analyses;
- Completing summary form for describing pertinent QA/QC information;
- Compiling raw data files – every item (i.e., standards, blanks, spikes, duplicates, and samples) relating to analysis; this includes all instrument printouts and copies of analysts' notebooks; and

As laboratory results are generated, the laboratory manager will initially review them. After review, the laboratory data manager assembles the data package. When the data package is complete, it is submitted to the laboratory QA/QC officer for final review. After the QA/QC officer reviews the file, the laboratory document control officer checks the complete file to verify that all required documents and information are present. Copies of all required deliverables are then printed on laboratory letterhead and faxed to the Omega Project Manager. A hard copy is later mailed to the Omega Project Manager. The laboratory maintains all original documents in numerical order in a locked file cabinet.

4.2.5.3 COC Management

Omega will maintain at least one copy of the COC in the appropriate project file. In addition, copies of COCs will be included with laboratory analytical results as appendices in all Omega deliverables where samples are submitted for laboratory analysis.

4.2.6 Analytical Results

Samples collected by Omega at State-Lead site will be submitted to a Commonwealth of Virginia certified laboratory for analysis. Laboratory analysis will be conducted according to U.S. Environmental Protection Agency and/or DEQ Storage Tank Program approved analytical methods. Omega will present analytical results in reports or other deliverables that are requested by the DEQ State-Lead Project Manager. The analytical results will be tabulated as a table in the text section of the report while the Certificate of Analysis included as an appendix. The Certificate of Analysis will be submitted to Omega on laboratory letterhead and signed by the laboratory QA officer. It will also include the following elements:

- Omega Project Number;
- Omega Point of Contact;
- Date samples received;
- Sample Extraction Date(s);
- Date Certificate of Analysis issued;
- List of parameters;
- Methods used;
- Detection Limits;
- Spike Recovery;
- Sample Dilution, if necessary; and
- Analytical results.

5.0 DATA VALIDATION

5.1 DATA REVIEW AND VALIDATION

Analytical data returned to Omega will be reviewed and validated to ensure that the results were acceptable and representative of site conditions. The data validation process involves a review of laboratory analytical reports and COCs. The following criteria will be used to validate laboratory analytical data:

- Sample holding time;
- Laboratory detection limits;
- Surrogate recoveries;
- Blanks;
- Calculation of Relative Percent Difference.

These criteria are discussed in the following subsections.

5.1.1 Sample Holding Time

The Omega Project Manager will review laboratory analytical reports to determine if samples are analyzed within the analyte's specified holding time. The holding time refers to the elapsed time interval between sample collection and the initiation of sample analysis. If the holding time for a particular analyte is exceeded, the quality of the laboratory data is suspected. When the holding time is exceeded, the Omega Project Manager will investigate the exceedance to determine if it can be attributed to the laboratory or to site-specific sample collection procedures.

Recommended sample containers, preservation, and maximum holding times for water and soil samples are given in Table 2 and 3, respectively.

Table 2 Requirements for Sample Containers, Preservation Procedures, and Maximum Holding Times for Water Samples

Parameter	Container	Preservation	Maximum Holding Time
Bacterial			
Coliform, total	P,G	Cool 4°C, 0.008% Na_2O_3	6 hours
Coliform, fecal	P,G	Cool 4°C, 0.008% Na_2O_3	24 hours
Inorganics			
Acidity	P,G	Cool, 4°C	14 days
Alkalinity	P,G	Cool, 4°C	14 days
Ammonia	P,G	Cool, 4°C, H_2SO_4 to pH < 2	28 days
Bromide	P,G	None required	28 days
Biochemical Oxygen Demand	P,G	Cool, 4°C	48 hours
Chemical Oxygen Demand	P,G	Cool, 4°C, H_2SO_4 to pH <2	28 days
Chloride	P,G	None required	28 days
Chlorine, Total Residual	P,G	None required	28 days
Color	P,G	Cool, 4°C	48 hours

Parameter	Container	Preservation	Maximum Holding Time
Fluoride	P,G	None required	28 days
Hydrogen ion (pH)	P,G	None required	Analyze Immediately
Metals			
Chromium VI	P,G	Cool, 4°C	24 hours
Metals except Chromium VI and Mercury	P,G	HNO_3 to pH < 2	6 months
Nitrogen, Ammonia	P,G	Cool, 4°C	28 days
Nitrate-nitrite	P, G	Cool, 4°C, H_2SO_4 to pH < 2	28 days
Oil and Grease	P,G	Cool, 4°C, H_2SO_4 to pH < 2	28 days
Organic Carbon	P,G	Cool, 4°C or H_2SO_4 to pH <2	28 days
Orthophosphate	P,G	Filter on site, Cool, 4°C	48 hours
Oxygen, Dissolved Probe	G bottle and top	None required	Analyze Immediately
Oxygen, Dissolved Winkler	G bottle and top	Fix on site and store in dark	8 hours
Phenols	G only	Cool, 4°C, H_2SO_4 to pH < 2	28 days
Phosphorus (elemental)	G	Cool, 4°C	48 hours
Phosphorous, Total	P,G	Cool, 4°C, H_2SO_4 to pH < 2	28 days
Residue, Total	P,G	Cool, 4°C	7 days
Residue, Filterable	P,G	Cool, 4°C	7 days
Residue, Nonfilterable	P,G	Cool, 4°C	7 days
Residue, Settleable	P,G	Cool, 4°C	48 hours
Silica	P	Cool, 4°C	28 days
Specific Conductance	P,G	Cool, 4°C	28 days
Sulfate	P,G	Cool, 4°C	28 days
Sulfide	P,G	Add 2 ml zinc acetate plus NaOH to pH > 9	7 days
Sulfite	P,G	None required	Analyze Immediately
Surfactants	P,G	Cool, 4°C	48 hours
Temperature	P,G	None required	Analyze Immediately
Turbidity	P,G	Cool, 4°C	48 hours
Organics			
Purgeable Halocarbons	G, Teflon-Lined Septum	Cool, 4°C, 0.008% Na_2O_3	14 days
Purgeable Aromatic Hydrocarbons	G, Teflon-Lined Septum	Cool, 4°C, 0.008% Na_2O_3, HCl to pH 2	14 days
Acrolein and acrylonitrile	G, Teflon-Lined Septum	Cool, 4°C, 0.008% Na_2O_3, adjust pH to 4-5	14 days
Phenols	Amber G, Teflon-Lined Septum	Cool, 4°C, 0.008% Na_2O_3	7 days until extraction, 40 days after extraction
Benzidines	Amber G, Teflon-Lined Septum	Cool, 4°C, 0.008% Na_2O_3	7 days to extraction

Parameter	Container	Preservation	Maximum Holding Time
[illegible]	[illegible]	[illegible]	[illegible]
PCBs	Amber G, Teflon-Lined Septum	Cool, 4°C	7 days until extraction, 40 days after extraction
[illegible]	[illegible]	[illegible]	[illegible]
PAHs	Amber G, Teflon-Lined Septum	Cool, 4°C, store in dark, 0.008% Na_2O_3	7 days until extraction, 40 days after extraction
[illegible]	[illegible]	[illegible]	[illegible]
Chlorinated Hydrocarbons	G, Teflon-Lined Cap	Cool, 4°C	7 days until extraction, 40 days after extraction
[illegible]	[illegible]	[illegible]	[illegible]
Pesticides	G, Teflon-Lined Cap	Cool, 4°C, pH 5-9	7 days until extraction, 40 days after extraction

Parameter	Container	Preservation	Maximum Holding Time
[illegible]	[illegible]	[illegible]	[illegible]
Semi-Volatile Organics	G, 8WT	Cool, 4°C	14 days until extraction, 40 days after extraction
[illegible]	[illegible]	[illegible]	[illegible]
Chromium VI	P, G, 8W	Cool, 4°C	24 hours
[illegible]	[illegible]	[illegible]	[illegible]

5.1.2 Laboratory Detection Limits

Laboratory analytical results will be reviewed by the Omega Project Manager to evaluate whether listed detection limits for most analytes can be achieved to meet DQOs. Matrix effects (e.g., particular matter) may result in sample dilution and elevation of analyte detection limits.

5.1.3 Surrogate Recoveries

Surrogate recovery data included on laboratory analytical reports will be reviewed by the Omega Project Manager to determine if it is within acceptable ranges (80-120 percent) for selected petroleum constituents.

5.1.4 Blanks

If field QC samples (trip, equipment, ambient, or source) are submitted to the laboratory, Omega will review analytical data for those samples. The presence of petroleum constituents or other organic analytes in the blank samples indicates sample integrity may be compromised. If analytes are detected in the blank sample(s), the Omega Project Manager will consult with the Regional State-Lead Project Manager to determine appropriate corrective action.

5.1.5 Calculation of Relative Percent Difference

If field duplicate samples are collected, Omega will calculate the relative percent difference (RPD) to assess comparability of results. The RPD for a sample is defined as the absolute difference of the parameter values from a sample and its corresponding duplicate divided by the mean, and multiplied by 100 to produce a percentage. This method is described in the U.S. Environmental Protection Agency Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses (dated February 1, 1988). A RPD of 20-25 percent is generally considered an indicator of comparable results.

5.1.6 Qualified Data

Qualified data may not be able to meet data quality objectives for the data collected. Common data qualifiers are listed in Table 4. The Omega Project Manager will consult with the DEQ Regional Project Manager to determine appropriate corrective action.

Table 4 Data Qualifiers

Qualifier	Description
J	The analyte was positively identified but the quantitation is an estimate.
U	The analyte was analyzed for but not detected. The associated numerical value is at or below the method detection limit.
R	The data was unusable due to deficiencies in the ability to analyze the sample and meet QC criteria.
B	The analyte was detected in the associated blank, as well as in the sample.

5.1.7 Field Performance and Audits

Field performance and system audits include on-site independent evaluation of sample collection, analysis, instrument calibration, measurement, and documentation procedures. Although these audits are qualitative, they can readily evaluate the capability and performance of project personnel, instrumentation, field activities, and project documentation.

The Omega Quality Assurance Manager or their designee may audit fieldwork and project documentation. Each auditor will have the organizational freedom to identify quality problems and to initiate, recommend, or provide solutions to quality problems and verify that corrective action has been implemented. Auditors will not be responsible for directing the technical aspects of the State-Lead investigation.

Generic audits of the Omega QA/QC program will be performed periodically for each engineering or environmental program and/or regional operation. Audits shall be performed at a frequency based on the results of previous audits. The need for audits shall be based on the following considerations:

- The importance of the activity to successfully complete stated corporate objectives;
- Significant changes in the functional areas of the QA program, such as significant reorganization or procedural revisions;

- A suspected nonconformance in an item or service; or
- The necessity to verify that required corrective action is implemented.

At the discretion of the Corporate QA/QC officer, a comprehensive project audit may be conducted prior to initiating fieldwork at State-Lead sites requiring collection of a large data set. The auditor may review the following:

- Chain-of-custody forms;
- Sample labels;
- Log books;
- Health and safety protocols;
- Sampling equipment;
- Sampling techniques;
- Decontamination procedures;
- Collection of field duplicate and blank samples; if required;
- Sample storage, security, and transportation;
- Sample containers;
- Contaminated waste storage and disposal

5.1.8 Corrective Action

Occasionally, unforeseen circumstances occur during field operations that might preclude collecting field data according to specified procedures. Changes in sampling procedures could potentially result in project-specific DQOs not be achieved. Therefore, if an alternative to standard sampling procedures must be implemented, Omega field personnel will contact the Omega Project Manager for approval. If the change in procedure is significant, the Omega Project Manager will contact the Virginia DEQ Regional State-Lead Project Manager for final authorization. Omega field personnel will document any changes in sampling protocols on a standardized field form with the following information:

- Project Name and Number;
- Material Sampled or parameter measured;
- Reason for change in field procedure;
- Variation of field procedure;
- Special equipment, materials, or personnel required to collect sample;
- Name, date, and signature of field personnel requesting change in sampling protocol; and
- Name, date, and signature of Omega Project Manager.

Omega shall implement corrective action immediately if the results of a field audit or review of analytical data identify QA problems that could preclude achieving DQOs. Re-sampling may be required if analytical results are reported outside acceptable limits. Omega field personnel will document corrective action taken on a standardized field form with the following information:

- Project Name and Number;
- Sampled Data Involved;

- Measurement Parameters;
- Acceptable Data Range;
- Problems Requiring Corrective Action;
- Corrective Action;
- Means of Detecting Problems and Verifying Correction;
- Name, Date, and signature of field personnel performing corrective action; and
- Name, date, and signature of Omega Project Manager.

Forms documenting changes in sampling procedure and corrective action will be included in the individual project file.

6.0 REFERENCES

U.S. Environmental Protection Agency, 1988, *Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses.* Office of Emergency and Remedial Response. EPA Publication 540-R-94/082, 48p.

U.S. Environmental Protection Agency, 1993, *Data Quality Objectives Process for Superfund – Interim Final Guidance.* Office of Solid Waste and Emergency Response. EPA Publication 540-R-93-071, 121p.

OMEGA ENVIRONMENTAL SERVICES

STATE LEAD QUALITY ASSURANCE PROJECT PLAN ADDENDUM

Soil Vapor Survey Standard Procedure

IFB #00-04BS

Table of Contents

1.0 SOIL VAPOR SURVEYS

1.1 Introduction

Soil vapor surveys, also referred to as soil gas surveys, are an effective and relatively inexpensive method for detecting VOCs and/or petroleum hydrocarbons in the vadose zone. These surveys are particularly useful in monitoring subsurface conditions arising from the release of petroleum constituents in the vicinity of underground storage tanks. Soil vapor surveys record the interaction and partitioning, migration, emplacement, and degradation of organic constituents in the subsurface. The primary objectives of soil vapor surveys are to:

- Qualitatively assess the extent of VOC and/or petroleum constituent vapors in overburden soils;
- Locate source areas ("hot spots") of organic vapors in the vadose zone; and
- Track probable paths of contaminant migration from these areas.

The results of the soil vapor survey shall be used to optimize the location of soil borings and monitoring wells. In addition, the results can be used to target specific locations for corrective action (e.g., soil excavation and removal) and performing remediation system pilot tests.

1.2 Program Design

Omega shall design a soil vapor survey after evaluating the following factors:

- Size of affected area;
- Relative permeability of overburden soils;
- Estimated depth to groundwater;
- Estimated depth to bedrock;
- Nature of site cover materials; and
- Past and current operational practices at the site which may have resulted in the release of petroleum constituents to the subsurface.

1.3 Sample Methodology

Depending upon anticipated soil permeability and relative contaminant concentrations, Omega shall use either a Whole Air - Active Approach or Sorbed Contaminants - Passive Approach to conduct soil vapor surveys. To conduct the soil vapor survey in a cost-

effective manner, Omega shall use sampling grids of variable design and spacing so that sufficient sample data coverage for the site can be established.

1.3.1 Whole Air - Active Approach

The Whole Air Active Approach shall be used if subsurface soils are permeable and contaminant concentrations are anticipated to be high. If used, a pilot hole shall be advanced using a solid, 3-foot-long, 5/8-inch outside diameter (OD) stainless steel rod equipped with a hardened stainless steel probe tip. An electric rotary hammer or similar device such as a slam bar shall be used to drive the probe tip and hollow drive extensions into the ground. Upon reaching the desired sampling depth or refusal, whichever occurs first, the probe tip and drive rods shall then be withdrawn from the pilot hole with a retrieval jack. The pilot hole shall then be redrilled with the electric rotary hammer using the stainless steel rod equipped with a retractable tip attached to the lead drive rod. The retractable tip contains a series of small holes that serve as sample ports that allow soil vapor to enter the interior of the probe. Steel gauze is placed over the sample ports to preclude native subsurface soil from clogging the small holes. Teflon™ tubing is threaded through the hollow drive rods and connected to the retractable tip and used to transport soil vapor to ground surface. At ground surface, visible annular space created by advancing and redrilling the pilot hole shall be backfilled and sealed at the surface with either aluminum foil or bentonite to minimize introducing ambient air into the soil vapor sample.

Prior to recording soil vapor concentrations at each sample location, an electric-powered vacuum pump shall be used to purge ambient air for a minimum of 5 minutes. Teflon™ tubing shall be connected to a FID or PID via a short piece of dedicated, clear, and flexible PVC tubing. The FID or PID shall be run a minimum of 5 minutes with the highest response recorded on soil vapor data sheets. These sheets will be included as an appendix in State-Lead reports, maintained as project files, and made available to DEQ personnel upon request.

1.3.2 Sorbed Contaminant - Passive Approach

The Sorbed Contaminant – Passive Approach may be used at sites with known or suspected low soil permeability. This method involves collecting soil vapor samples on a granulated adsorbent material over time. Granular adsorbent materials such as Tenax-TA® and carbonaceous resins are used due to their affinity for a broad range of VOCs and SVOCs. This combination provides high sensitivity to VOC and SVOCs, and minimizes fluctuations in soil vapor availability due to changing ambient air and subsurface conditions. In addition, unlike active soil vapor sampling methods, passive soil gas sampling does not disrupt the natural equilibrium of vapors in the subsurface.

Omega shall use passive sorbent collection devices (sorbers) to conduct passive soil vapor surveys. The sorbers are sheathed in an insert, glass tube, open in one end. They are hydrophobic but do not retard vapor transport. The sorbers will be placed below ground surface (approximately 2-3 feet) after a pilot hole has been advanced to its desired sampling depth using an electric rotary hammer or slam bar. Pilot holes shall be located

on a sampling grid established prior to initiating the sampling program. It is anticipated the sorbers will remain in the ground up to 14 days after insertion to record exposure to contaminant migration in the vadose zone.

1.4 Sample Identification Procedures

During active soil vapor surveys, it may be necessary to document the changes of soil vapor with depth. If so, the shallow soil vapor sample shall be designated as "A" while the deeper overburden sampling points labels as "B", "C", and so on.

For the passive soil vapor survey, Omega personnel will assign a field identifier to each sample after inserting the sorber. After insertion, an identification stake or marking shall be placed adjacent to each soil vapor sample location. Field identifiers will appear on sample labels, chain-of-custody forms, field sampling forms, and in field log books used by Omega. The location of each active or passive soil vapor sampling point shall be promptly plotted on the base site maps. Pertinent field observations (e.g., location, date and time of sampling, weather conditions, soil composition, moisture content, sample depth(s), and contaminant odors) will be recorded with indelible ink on a sample data sheet.

1.5 Sample Handling Procedures

Omega shall collect each sorber from their designated location after the soil vapor samples have been exposed to contaminant migration in the vadose zone. Depending upon conditions encountered and manufacturer's recommendations, it is anticipated the sorbers will be left in the field for 3-14 days.

Following collection, the soil vapor samples will be resealed in their designated shipping vials and immediately placed on ice in an insulated cooler. COC forms will be completed in the field and accompany the samples back to the analytical laboratory. Trip blanks will also be returned with the soil vapor samples. No preservatives, other than cooling to 4°C will be used with the soil vapor samples. To minimize movement and/or potential breakage of sample containers during transport, the samples will be packed with shock-absorbent materials such as bubble wrap. Strapping tape will be wrapped completely around the coolers to secure the lid(s) of the cooler(s). Each cooler will be labeled "Fragile" and "This End Up" and shipped via overnight according to Department of Transportation regulations and procedures to the analytical laboratory. Air bills will be properly completed in the field with copies retained and placed in the project file.

1.6 Chain-of-Custody Record

After collecting the sorbers, Omega personnel will fill out, sign and data a COC form in indelible ink. The on-site supervisory geologist or engineer will verify that all COC forms are legible, complete, and accurate. The COC form(s) shall then be placed in a resealable plastic bag and taped to the inside lid of the cooler. COC forms will be

completed for every sample and accompany shipment of sorbers to the analytical laboratory. The completed COC form(s) shall contain the following information:

- Sample or soil vapor identification number:
- Signature of sampler(s) involved in COC;
- Date and time of collection;
- Place of collection;
- Sample type; and
- Inclusive dates of possession.

Designated laboratory personnel will complete the laboratory portion of the COC form. It shall include the following information:

- Name of person receiving the sorbers;
- Laboratory sample number;
- Date of sample receipt;
- Analyses requested; and
- Remarks concerning sample condition and temperature.

1.7 Quality Assurance/Quality Control (QA/QC) Measures

A number of QA measures shall be taken to assure sample representativeness. They include the following:

- All sorbers will be individually numbered and tracked through manufacturing, field deployment, and analytical procedures;
- Each sorber will be sealed in a clean glass vials and transported to the field site and packed inside coolers supplied by the analytical laboratory;
- A specified number of trip blanks will accompany the sorbers to and from the field sites; and
- A specified number of sorbers will be installed as duplicates that will be placed in separate pilot holes advanced within 1 foot of the original pilot hole.

Quality Assurance Procedures
Swift Creek Environmental, Inc.

STATE LEAD CONTRACT
IFB #00-04BS

INVESTIGATION & REMEDIATION OF PETROLEUM CONTAMINATION

April 21, 2000

SUBMITTED BY:
Swift Creek Environmental, Inc.
15210 Martin Glen Terrace
Midlothian, Virginia 23112
804.739.9124

SWIFT CREEK ENVIRONMENTAL, INC. QA/QC PROGRAM

The QA/QC Plan adopted by Swift Creek Environmental, Inc., is in accordance with acceptable methodological and analytical procedures set forth by the various regulatory agencies and private industry. The methods executed are designed to maintain accepted United States Environmental Protection Agency (USEPA) sampling, decontamination and analytical techniques (United States Environmental Protection, Characterization of Hazardous Waste Sites, A Methods Manual, 1984). If awarded the contract, this QA/QC Plan will be modified to meet the VDEQ's Quality Assurance Project Plan, State Lead Program. In instances where this QA/QC Plan does not address specific VDEQ's Quality Assurances for the State Lead Program, the VDEQ's Quality Assurance Project Plan for the State Lead Program dated, March 1, 2000 will apply until such time this QA/QC Plan can be modified and or adjusted.

PROJECT MANAGEMENT AND RESPONSIBILITIES

Project Manager - In Charge of site project - All Aspects
Corporate QA/QC Manager- In charge of all QA/QC Matters - Interfaces directly with VDEQ QA/QC Manager
Health and Safety Officer - Insures all Health and safety Matters are being complied
Staff Scientists/Geologists - Performs all technical aspects of project
Technicians - Performs all non-technical field aspect of project
Others - Assists management and technical staff in completing a project

2.0 SAMPLING SPECIFICATIONS

A truck mounted drilling rig is used to collect soil samples at designated locations when desired sampling depths are greater than one (1) foot (a hand operated split spoon sampler and stainless steel trowel is used in instances where applicable) Soil samples are obtained at each bore hole location using hollow stem augers and a standard split spoon sampler. Soil samples are collected by driving a standard two (2) foot long decontaminated split spoon sampler ahead of the augers into the subsurface sediment. Once the split spoon has fully penetrated a minimum of two (2) feet of sediment, it is recovered to the surface for collection and field examination. The sample is examined and logged in the field by a qualified technician noting the physical characteristics of coloration, texture, odor, and signs of obvious contamination and stored in a cooler at four (4) degrees Celsius.

A portable monitoring device such as a photo-ionization detector (PID), flame ionization detector (FID), or a combustible gas indicator (CGI) is used during drilling operations to detect possible explosive conditions.

Soil samples being tested for volatile organic compounds (VOC) are containerized immediately upon recovery. The samples, are placed in air tight vials (with no head space), labeled and refrigerated. Additional samples (with head space) are placed in wide mouth jars for testing additional analytical parameters. All soil samples selected for laboratory analysis are determined by the organic vapor analysis and/or specifically targeted depths. In instances where the organic vapor analysis reveals no detectable levels of organic vapor, the samples are selected based on visual examination of physical characteristics.

HEAD SPACE ANALYSIS

Head space organic vapor analysis are preformed in the field, utilizing a photo-ionization detector (PID), on all samples collected during the drilling of the soil test borings. Calibration tests on the PID will be conducted monthly by a qualified individual and yearly by the manufacturer.

In addition to the soil samples that are collected for laboratory analysis of VOC, additional samples are placed into a wide mouth glass jars (with head space) sealed with aluminum foil, secured with a rubber band, and shaken in order to allow any trapped vapor within the pore space to occupy the head space of the jar. After being stored for a uniform period of time, a clean probe is injected through the foil to measure the organic vapor profile for each bore hole.

All field instruments will be maintained and performed by qualified individuals. The QA/QC manager will inform staff of VDEQ QA/QC requirements and monitor and record QA/QC documents.

MONITOR WELL SPECIFICATIONS

The bore holes for the monitor well(s) are drilled using the hollow stem auger drilling technique (6-5\8 inch I.D. for 4 inch wells and 4-1\4 inch I.D. for 2 inch wells). The monitor wells specifications consist of either a 2" or 4" PVC flush joint casing, and slotted PVC screen. No glues or solvents are used during the construction of the monitor wells. A ten (10) foot well screen is placed approximately seven (7) feet below and three (3) above the static water level (where applicable). The bore holes are backfilled with clean, # 2 well sorted sand to two (2) feet above the well screen followed by two (2) feet of bentonite pellets. The remaining annular space is filled with bentonite grout to approximately one (1) foot below the existing grade. The well heads are encased in access boxes and secured in place with concrete at grade. Locking caps are installed at the completion of each well.

MONITOR WELL DEVELOPMENT

The ground water monitor wells are developed by removing five (5) times the volume of the water in the well using a disposable bailer. A new bailer for each individual well is used to prevent cross contamination.

GROUND WATER LEVEL MEASUREMENTS

Prior to measuring ground water levels in the monitor wells, the well head elevation is determined. Measurements of depth to ground water (DTW) in each well is taken using a conductivity water level probe with an audible signal. The field data is compiled to determine the local ground water directional flow component. Water level measurements are taken prior to collection of ground water samples and approximately seventy-two (72) hours after sample collection.

GROUND WATER SAMPLING SPECIFICATIONS

The ground water monitor wells are sampled according to the following protocol:

1. Prior to sampling, the DTW is determined in each monitor well.
2. The volume of standing water is calculated.
3. The wells are purged, removing five (5) times the volume of standing

water in each well, using a decontaminated bailer

4. Ground water samples are collected using a single use disposable bailer and rope which are discarded after each use.
5. The ground water samples are placed in appropriate containers, labeled and refrigerated.

DECONTAMINATION PROTOCOL

In instances prior to collection of soil or aqueous samples, all sampling equipment is decontaminated as follows:

1. Non-phosphate detergent plus tap water wash
2. Tap water rinse
3. Deionized water rinse
4. 10% nitric acid rinse*
5. Deionized water rinse *
6. Acetone rinse**
7. Air Dry**
8. Deionized water rinse**

* only if sample is analyzed for metal
** only if sample is analyzed for organic constituents

In addition, the hollow stem augers drilling rods, drill bits, etc. are pressure cleaned prior to use at each boring followed by a non-phosphate detergent plus tap water wash.

LABORATORY ANALYSES

All samples are collected by qualified Swift Creek Environmental, Inc. personnel in accordance with established sampling and decontamination protocols.

The preservation techniques, holding times, containerization and laboratory methods for a variety of soil and aqueous samples are described in the Table.

TABLE. Soil, Sludge and Ground Water Sample Protocols

Parameter	Laboratory Method	Container	Preservation	Maximum Holding Time
Halogenated and Aromatic Volatile Organic Compounds (includes BTEX)	601/602 624/625 8010/8020 8240/8270	Glass, teflon lined cap	Cool, 4° C.	7 days
Arsenic	206.3	Poly., Glass	HNO3 to Ph<2 or in soil, Cool, 4° C.	6 mos.
Barium	200.7	Poly., Glass	HNO3 to Ph<2 or in soil, Cool, 4° C.	6 mos.
Cadmium	213.2	Poly., Glass	HNO3 to Ph<2 or in soil, Cool, 4° C.	6 mos.

TABLE. Soil, Sludge and Ground Water Sample Protocols

Parameter	Laboratory Method	Container	Preservation	Maximum Holding Time
Chromium	218.1	Poly., Glass	HNO3 to Ph<2 or in soil, Cool, 4° C.	6 mos.
Lead	239.2	Poly., Glass	HNO3 to Ph<2 or in soil, Cool, 4° C.	6 mos.
Mercury	245.1	Poly., Glass	HNO3 to Ph<2 or in soil, Cool, 4° C.	28 days
Selenium	270.3	Poly., Glass	HNO3 to Ph<2 or in soil Cool, 4° C.	6 mos.
Silver	272.1	Poly., Glass	HNO3 to Ph<2 or in soil Cool, 4° C.	6 mos.
Organo-chlorine Pesticides	608/8010	Glass teflon lined cap	Cool, 4° C.	7 days
PCB's	608/8080	Glass teflon lined cap	Cool, 4° C.	7 days
Phenoxy-acid Herbicides	615/8150	Poly., Glass	Cool, 4° C.	7 days
Organo-phosphorous pesticides	8140	Poly., Glass	Cool, 4° C.	7 days
TCLP Extractions Volatiles		Glass, teflon lined cap	Cool, 4° C.	7 days
TCLP Extraction Semi-volatiles		Glass, teflon lined cap	Cool, 4° C	7 days
TOC	415.1	Glass, teflon lined cap	Cool, 4° C, HCL to Ph<2	28 days
TOX	450.0	Glass, teflon lined cap	Cool 4° C, 1ml 0.1 M sodium sulfite	7 days
TPH	418.1	Glass, teflon lined cap	Cool, 4° C. H2SO4 to Ph<2	28 days

In addition, proper Chain of Custody measures are followed to allow for the tracing of possession and handling of individual samples from the time of field collection through laboratory analysis. The Chain of Custody program includes the following:

1. Sample labels
2. Samples seals
3. Field logbook
4. Chain of Custody record
5. Sample analysis request sheets
6. Laboratory analysis logbook

UNDERGROUND LINE LOCATOR

Underground line location is performed by visual inspection of above ground connections and surface features, marking by Miss Utility, inspection of public records, discussions with local residents and by tracing with a magnetic and line locator.

JOB TRAINING AND SAFETY PROCEDURES

All Swift Creek Environmental, Inc. field personnel have completed a 40-hour Health and Safety Training course that complies with OSHA 1910.120(e)(2). All field personnel attends an annual Heath and Safety refresher course.

DATA REVIEW

Data review and validation will be performed routinely by the QA/QC Manager and provide any necessary documentation to the VDEQ as required.

STATE LEAD CONTRACT
IFB #00-04BS

INVESTIGATION & REMEDIATION OF PETROLEUM CONTAMINATION

May 2, 2000 - Response

SUBMITTED BY:
Swift Creek Environmental, Inc.
15210 Martin Glen Terrace
Midlothian, Virginia 23112
804.739.9124

Section 4

This section entails the requested information regarding QA/QC procedures as stated in DEQ's letter, dated May 2, 2000.

A) Swift Creek Environmental, Inc., standard procedure for conducting a soil vapor survey includes:

1. Mobilization to the site.
2. Visually survey the property to determine ideal location(s) and number of soil probes.
3. Submit appropriate documentation and AAF to the DEQ to perform the soil vapor survey.
4. Drill boreholes utilizing hand auger, drill rig or geoprobe to desired depths.
5. Install 1-inch schedule 40 .2 slot PVC well screen and casing to desired depths.
6. Surround well screen with filter pack followed by bentonite seal and grout.
7. Cap well with air tight locking cap with sample access port.
8. Initially screen wells for organic vapors utilizing appropriate field instruments (i.e., PID-OVA).
9. Allow minimum 24 hours (if requested by the DEQ) to collect air samples from the wells utilizing industry standard methodologies including air pump, hoses and collection bags.
10. Record all field and office events in a bound log book during execution of the project and transport the samples to an independent testing laboratory following industry standard sampling, containerization and transportation protocols.
11. Analyze samples for DEQ approved parameters.
12. Review field data and chemical results for QA/QC.
13. Submit findings to the DEQ.

These standards were adopted from the EPA for a soil gas survey of ***Hazardous Waste Sites, a Methods Manual - Volume II (PB85-168771)***. Attached is a diagram of EPA's protocol and procedures ***4-64 through 4-66.***

A second procedure performing a soil gas survey has also been adopted by Swift Creek Environmental, Incorporated. These procedures are accomplished following the attached pages of EPA methods for conducting a soil gas survey of ***Hazardous Waste Sites, a Methods Manual - Volume II (PB85-168771) 4-62 through 4-63.***

Standard procedures can be modified to perform chemical analyses on-site or other methodologies can be used that are not under EPA guidance if the DEQ desires. On-site chemical analyzation is not typically performed since we have found the cost to perform on-site analyzation to be more expensive and the above methodology to be more cost effective for the DEQ. As such, field analyzation is typically denied or considered excessive with regards to VUPSTF projects.

B). Regarding the inspection, testing, calibration and maintenance of field instruments, Swift Creek Environmental, Inc., has adopted the following procedures.

HNu - To insure that our HNu is reliable and in good working order we have implemented our procedures strictly following the instruction manual. Prior to mobilizing to the project, the HNu is turned on to insure that it is in good working order and visually inspected to insure it is not damaged. This procedure will be documented

4.3.2 METHOD IV-11: MONITORING GAS AND VAPORS FROM WELLS

Discussion

The sampling of wells for gases and vapors can be accomplished by lowering an intake probe through a sealed cap on the top of the well, (Figure 4-8). The intake probe should be of a nonsparking material that will further minimize adsorption or desorption effects. Teflon or glass are preferable to steel or brass in this application. The intake probe is then connected to the desired gas monitor such as those described in the ambient gases section and Methods IV-1 through IV-8.

Uses

Existing groundwater monitoring wells can be used to check for the presence of those gases volatilized or otherwise liberated from the groundwater. In some cases, the groundwater level will be below the top of the screened portion of the well allowing free soil gases to enter the well casing.

Wells especially designed for soil-gas monitoring can also be placed by conventional well placement techniques. The well casing, however, is perforated the entire distance, the annular space is packed with gravel, and the top is sealed with a grout cap.[40] The top of the casing can even be equipped with a sampling valve to allow easy coupling to the monitoring instruments.

Procedures for Use

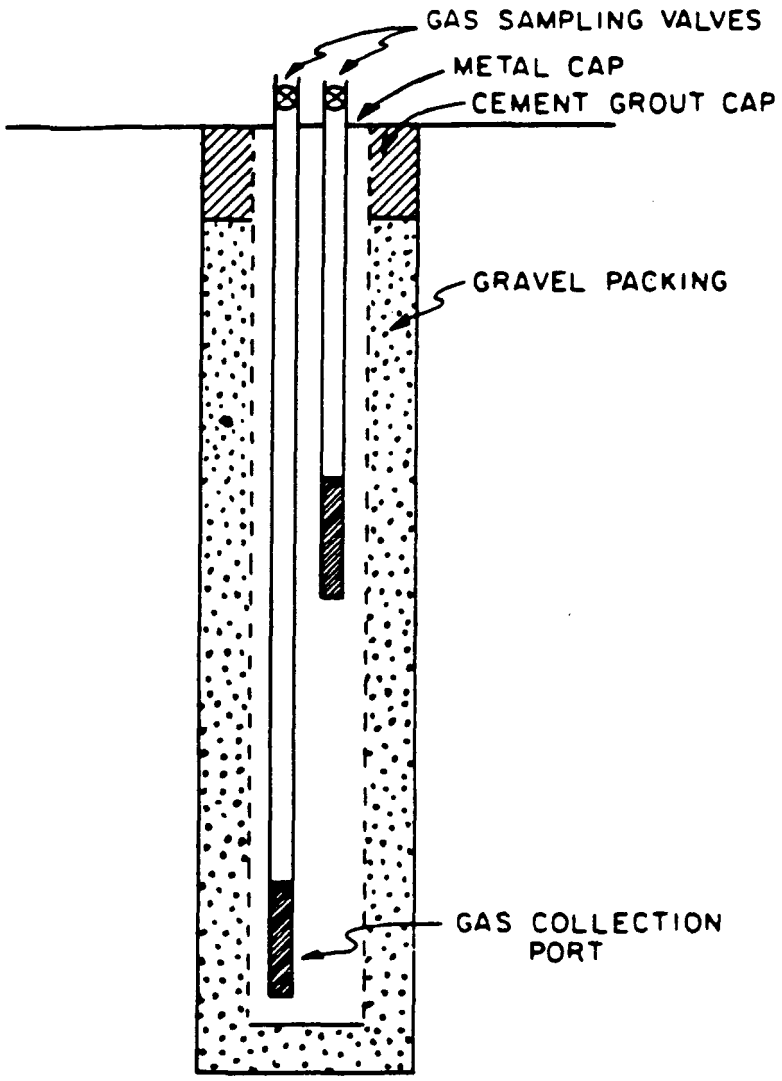
1. Sound the well for water level or bottom.

2. Select the required length of Teflon tubing. It should be of sufficient length to approach the water level or well bottom, but not so long as to allow water or bottom sediments to enter probe inlet. An inside diameter of 1/8 inch is usually sufficient. However, because this size lacks rigidity, a small weight can be secured to the inlet end to facilitate placement.

3. Lower the tubing through an appropriate sized stopper on the top of the well casing. A wooden plug serves well. It is not critical to maintain an effective seal around the tubing.

4. Lower intake to near bottom and attach outlet to monitor inlet.

5. Proceed with instrument operation according to Methods IV-1 through IV-8 or the instrument operator's manual. Note: When using an adsorption technique for qualification/quantification, Sisk[4] recommends a sample rate of 1 lpm for 5 to 30 minutes through Tenax GC (see Method IV-7).



Source: Reference 40.

Figure 4-8. Gas sampling well.

6. Gradually raise the intake tubing while observing the instrument readings.

7. Record readings, then remove probe and close casing.

8. If instrument fails to return to background level, replace sample inlet tube before proceeding to next well. Note: Sometimes vapors may condense on the lower portion of the sample tube, merely cutting off the bottom several centimeters of the intake tube may remove the source of contamination and allow reuse of the remaining sample tube.

Sources

Hatayama, H.R. "Special Sampling Techniques Used for Investigating Uncontrolled Hazardous Waste Sites in California." In: National Conference on Management of Uncontrolled Hazardous Waste Sites. Hazardous Material Control Research Institute, Silver Springs, Maryland. 1981.

4.3.1 METHOD IV-10: MONITORING GAS AND VAPORS FROM TEST HOLE

Discussion

Gas samples can be withdrawn from test holes by using a nonsparking probe, brass and Teflon being the most suitable. The probe is then attached to the gas inlet of the desired gas monitor such as those described in the ambient gases section and Method IV-1 through IV-8. The test holes are easily prepared by driving a metal rod (approximately 1 in. diameter) into the soil with a drive weight. Commercial bar hole-makers are available that combine the steel hole-making bar and drive weight into one unit (see Figure 4-7).[39]

Uses

This system is particularly adapted for rapid evaluation of waste sites for soil gas generation. When used in conjunction with a hydrocarbon analyzer or an explosimeter it can rapidly determine the areal extent of a waste site or the location of a particular emission source. It is recommended that the test area be screened with a metal detector before sampling.

Procedures for Use

1. Select location free from rocks and debris. Screen location with metal detector to varify absence of drums and pipes.

2. Place bar point on ground and raise drive weight, then allow weight to fall on bar. It is only necessary to guide the weight in its vertical travel.

3. Continue until desired depth or any penetration resistance is reached.

4. Remove bar hole-maker.

5. Attach suitable length of Teflon tubing (stainless steel or brass may be used in some instances but may result in some gas adsorption/ absorption) to monitor instrument gas inlet.

6. Lower tubing into test hole and operate monitor or gas sampling device as listed in Methods IV-1 through IV-8.

7. Record results.

8. Remove sample tubing and observe that instrument readings return to background. If not, change tubing before proceeding to next test location.

9. Tramp over and recover test hole.

Sources

Flower, F.B. "Case History of Landfill Gas Movement Through Soils." Rutgers University, New Brunswick, New Jersey.

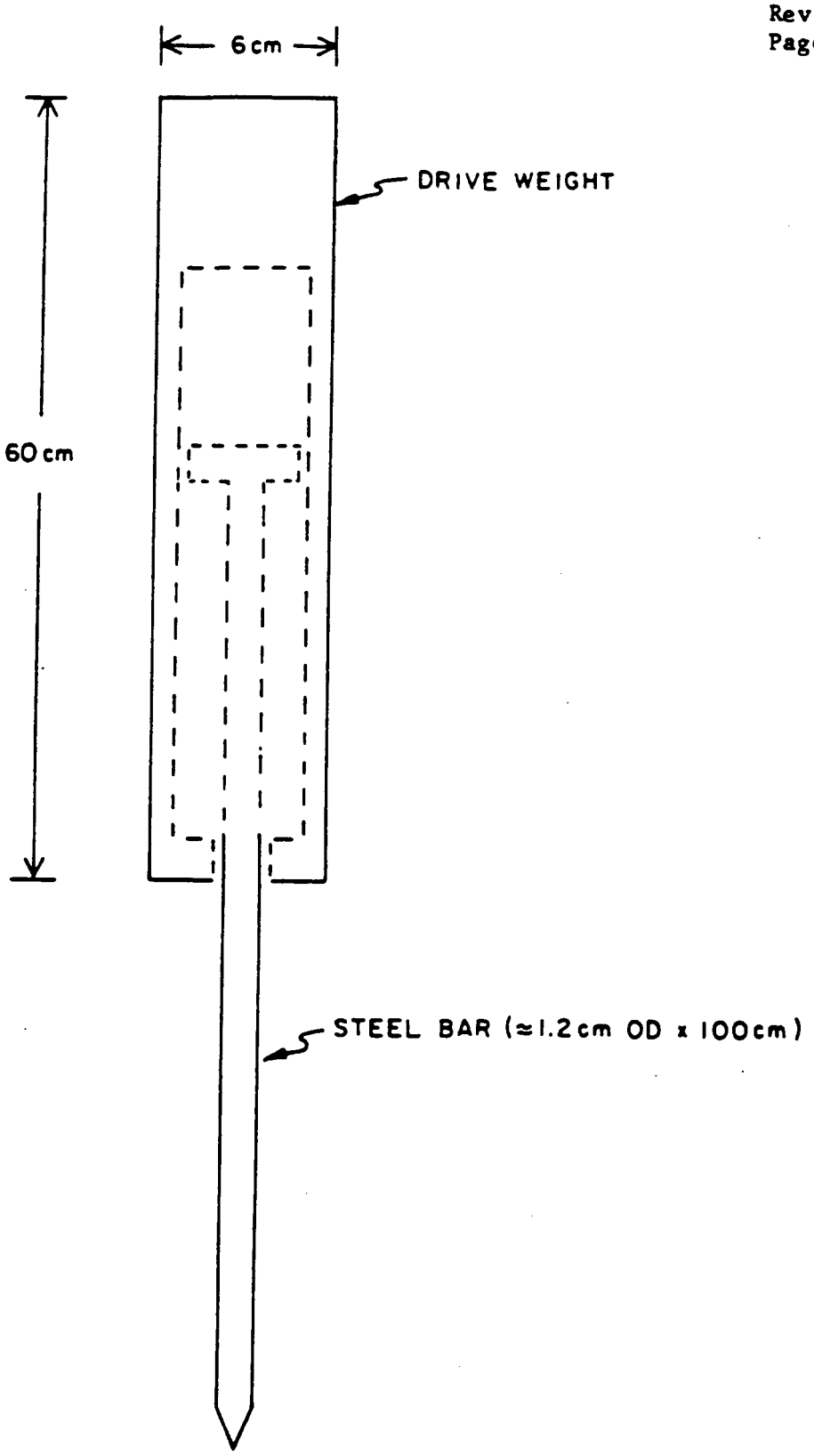


Figure 4-7. Bar hole-maker.

in the individuals bound log book on the day it is to be used. Prior to screening any soil, the HNu is tested to insure that it is properly functioning. This is accomplished by establishing known calibration as described in the instruction manual. To insure these procedures are being followed, Swift Creek Environmental, Inc., has adopted the attached form which is filled out by the individual cleaning/maintaining/using the instrument. The forms will be reviewed monthly by our QA/QC officer and initialed and dated on the date QA/QC review was performed. The completed forms will be maintained in a master log book. The HNu will be calibrated at least monthly by a qualified individual following manual procedures. To insure these procedures are being followed, Swift Creek Environmental, Inc., has adopted the attached form which is filled out by the individual calibrating the instrument. The forms will be reviewed by our QA/QC officer and initialed and dated on the date QA/QC review was performed. The completed forms will be maintained in the master log book. At a minimum, the HNu will be sent yearly to the manufacturer for cleaning/maintenance/calibration and documented in the master log book. Any discrepancies for the above procedures will be noted and if required, further instruction, training or repair will be conducted to insure the HNu records reliable results. This will also be recorded in the master log book. A copy of our HNu Manual is on file.

Pentex Survey Equipment including Stadia, Rod and Tripod - To insure that our Survey Equipment is reliable and in good working order we have implemented the following procedures. Prior to mobilizing to the site, the survey equipment will be visually inspected by the individual using the equipment to insure that it is in good working order. This procedure will be documented in the individuals bound log book on the day the survey equipment is to be used. In addition, on a monthly basis the equipment will inspected and cleaned. This procedure will be recorded in the master log book. A sample form is attached. The survey forms and log books will be reviewed monthly by our QA/QC officer and initialed and dated on the date QA/QC review was performed. The completed forms will be maintained in the master log book. Any discrepancies will be noted and if required, further instruction, training or repair will be conducted and recorded in the master log book.

Water Level Indicators - To insure that our water level indicators are reliable and in good working order we have implemented the following procedures. Prior to mobilizing to the site, the water level indicators will be visually inspected to insure that they are in good working order. This procedure will be documented in the individuals bound log book on the day the water level indicators are to be used. The water level indicators will also be cleaned between each well on site using an alconox wash solution followed by a tap water rinse. This procedure will be maintained in the individuals log book. On a monthly basis, the water level indicators will be inspected and cleaned using an alconox wash solution followed by a tap water rinse. This procedure will be recorded in the master log book. Additionally, on a monthly basis the water level indicators will be tested to insure that they are calibrated correctly. This procedure will entail measuring the depth to water from a known depth and compare the water level reading to the established depth. This procedure will be recorded in the master log book. If a discrepancy is noted, the water level indicator will be sent to the manufacturer for repair. The forms and log books will be reviewed monthly by our QA/QC officer and initialed and dated on the date QA/QC review was performed. The completed forms will be maintained in the master log book. Any discrepancies will be noted and if required, further instruction, training or repair will be conducted.

Liquid Ring Unit - The Liquid Ring Unit will be inspected weekly (when in-use) and prior to mobilization to the site by Mr. B.K. Eaton (Remediation Specialist). The attached sample form will be completed by Mr. Eaton and verified by the QA/QC director. A copy

Swift Creek Environmental, Inc. -- Equipment Maintenance/Testing Log

HNu

Date of Inspection/Testing	Date of last Calibration	Type of Maintenance Performed	Condition	Comments/Recommendation	Individual performing Task	QA/QC Review

Manufacturer Maintenance

Date Sent	Date Returned	Type of Maintenance/Repair Performed	REASON

Swift Creek Environmental, Inc. -- Equipment Maintenance/Testing Log

SURVEY EQUIPMENT

Date of Inspection/Testing	Type of Maintenance Performed	Condition	Comments/Recommendation	Individual performing Task	QA/QC Review

Manufacturer Maintenance

Date Sent	Date Returned	Type of Maintenance/Repair Performed	REASON

Swift Creek Environmental, Inc. -- Equipment Maintenance/Testing Log

WATER LEVEL INDICATOR (1)

Date of Inspection/Testing	Date of last Calibration	Type of Maintenance Performed	Condition	Comments/Recommendation	Individual performing Task	QA/QC Review

Manufacturer Maintenance

Date Sent	Date Returned	Type of Maintenance/Repair Performed	REASON

Swift Creek Environmental, Inc. -- Equipment Maintenance/Testing Log

WATER LEVEL INDICATOR (2)

Date of Inspection/Testing	Date of last Calibration	Type of Maintenance Performed	Condition	Comments/Recommendation	Individual performing Task	QA/QC Review

Manufacturer Maintenance

Date Sent	Date Returned	Type of Maintenanoe/Repair Performed	REASON

Swift Creek Environmental, Inc. -- Equipment Maintenance/Testing Log

WATER LEVEL INDICATOR (3)

Date of Inspection/Testing	Date of last Calibration	Type of Maintenance Performed	Condition	Comments/Recommendation	Individual performing Task	QA/QC Review

Manufacturer Maintenance

Date Sent	Date Returned	Type of Maintenance/Repair Performed	REASON

Swift Creek Environmental, Inc. -- Equipment Maintenance/Testing Log

LIQUID RING UNIT

Date of Inspection	Type of Maintenance Performed	Condition	Comments/Recommendation	Individual performing Task	QA/QC Review

Manufacturer Maintenance

Date Sent	Date Returned	Type of Maintenance/Repair Performed	REASON

of the completed form will be maintained in the master log book. Any piece of equipment that is not in satisfactory condition will be replaced upon receipt of the new part and recorded in the master log book.

C) Through the years various federal projects (regulated by the EPA) have required individuals within the Swift Creek Environmental, Inc., to perform a minimum of two ground water level gauging events during a ground water sampling event to insure QA/QC was addressed. By performing a minimum of two gauging events sample accuracy, sampling variability and sampling precision could be addressed. A minimum of two ground water gauging events were required to determine if any statistical variation was evident which could possibly affect the outcome of the analytical results. At this time, if the DEQ does not require statistical comparisons, Swift Creek Environmental, Inc., has modified its QA/QC procedure and eliminated this procedure.

D) The procedure to determine if free phase petroleum is present will be accomplished by either means, using an oil water interface probe or a new polyethylene disposable bailer for each well. After collecting water level readings the new disposable bailer will be placed down the well and retrieved. Measurements of product thickness will be recorded in the individuals bound log book. If an oil water interface probe is to be used, it will be cleaned prior to and after use on each monitor well following industry standard decontamination protocol. Decontamination procedures and results will be recorded in the individuals bound log book.

E) The procedure adopted for monitor wells that may have low recovery rates include performing a slug test on the suspect wells to determine recharge capabilities. Once this information has been obtained, the maximum amount of water that can be withdrawn prior to sampling in which the well can be adequately sampled will be removed.

F) Swift Creek Environmental, Inc., utilizes the following tables and have incorporated these tables in our QA/QC Manual which was have been taken directly from the EPA ***Hazardous Waste Sites, a Methods Manual - Volume II (PB85-168771), NCDEHNR, Guidelines for Investigation and Remediation of Groundwater, DEQ, Storage Tank Manual and Analytics Sample Methodologies.*** The following pages from these documents have been placed in our QA/QC Manual and are utilized as standard procedure for sample collection, preservation and holding times. If the DEQ desires Swift Creek Environmental, Inc., to modify these documents specifically to address other items not mentioned or there are conflicting agency protocols, we will modify these items and incorporate them into our Interim and Final State Lead Contract QA/QC Program Manual.

G) Monthly staff meetings will be conducted to insure that proper training and knowledge of the State Lead Contract Tasks are maintained. Additionally, **all** employees log books will be reviewed by the QA/QC Director and initialed. Training will include different topics each month in which employees will be given hand outs and documents on the particular training session. The individuals who will train the employees will be the QA/QC director and the person knowledgeable on the item(s) to be discussed. Training will include but not limited to State Lead Contract Protocols, Health and Safety Issues, Sample Collection, Preservation and Transportation procedures, equipment maintenance sessions, computer knowledge training and other QA/QC protocols. Each session will be approximately one hour/month for **all** Swift Creek Environmental, Inc., employees. Documentation of the training sessions will be maintained in the master log book with the persons in attendance signing the attached sample form and that individuals received the appropriate materials and the materials

Parameter	Collection technique	Container[a]	Preservation	Holding time[b]	Minimum required volume (mL)
Acidity	Grab or composite	P,G	Cool, 4°C	14 days	100
Alkalinity	Grab or composite	P,G	Cool, 4°C	14 days	100
Asbestos	Grab or composite	P	Cool, 4°C	48 hours	1000
Bacteria	Grab only	Pro, G	Cool, 4°C, 10% $Na_2S_2O_3$, EDTA	6 hours	200
Bicarbonate	Grab only	P,G	Determine onsite	No holding	100
BOD	Grab only	P,G	Cool, 4°C	48 hours	1000
Bromide	Grab or composite	P,G	None required	28 days	100
Carbonate	Grab only	P,G	Determine onsite	No holding	100
Chloride	Grab or composite	P,G	None required	28 days	50
Chlorine demand	Grab only	P,G	Determine onsite	No holding	200
Chromium VI	Grab or composite	P,G	Cool, 4°C	24 hours	100
COD	Grab only	P,G	H_2SO_4 to pH <2; Cool, 4°C	28 days	50
Color	Grab or composite	P,G	Cool, 4°C	48 hours	50
Conductance	Grab or composite	P,G	Cool, 4°C	28 days	100
Cyanide	Grab or composite	P,G	NaOH to pH >12, 0.6g Ascorbic acid[d]	14 days	500
Fluoride	Grab or composite	P	None required	28 days	300
Hardness	Grab or composite	P,G	HNO_3 to pH <2	6 months	100
Hydrazine	Grab or composite	P,G	If not analyzed immediately, collect under acid. Add 90 ml of sample to 10 ml (1 + 9) HCl	7 days	100

(continued)

TABLE A-1 (continued)

Parameter	Collection technique	Container[a]	Preservation	Holding time[b]	Minimum required volume (mL)
Iodide	Grab or composite	P,G	Cool 4°C	24 hours	100
Iodine	Grab only	P,G	Determine onsite	No holding	500
Metals (Except Cr VI)					
Dissolved	Grab or composite	P,G	Filter onsite, HNO_3 to pH <2	6 months, except Hg--28 days	200
Suspended	Grab or composite	P,G	Filter onsite	6 months, except Hg--28 days	200
Total	Grab or composite	P,G	HNO_3 to pH <2	6 months, except Hg--28 days	100
Nitrogen					
Ammonia	Grab or composite	P,G	Cool, 4°C, H_2SO_4 to pH <2	28 days	400
Kjeldahl (total)	Grab or composite	P,G	Cool, 4°C, H_2SO_4 to pH <2	28 days	500
Nitrate plus Nitrite	Grab or composite	P,G	Cool, 4°C, H_2SO_4 to pH <2	28 days	100
Nitrate	Grab or composite	P,G	Cool, 4°C, H_2SO_4 to pH <2	48 hours	100
Nitrite	Grab or composite	P,G	Cool 4°C, H_2SO_4 to pH <2	48 hours	50
Oil and Grease	Grab only	G	Cool 4°C, H_2SO_4 to pH <2	28 days	1000
Organics					
Extractables base/neutrals and acids)	Grab or composite	G, Teflon-lined cap	Cool, 4°C	7 days until extraction, 30 days after extraction	1000

(continued)

Parameter	Collection technique	Container[a]	Preservation	Holding time[b]	Minimum required volume (mL)
Organics (cont.)					
Purgeables (halocarbons-aromatics)	Grab only	G, Teflon-lined cap	Cool, 4°C	14 days	40
Purgeables (acrolein and acrylonitrile)	Grab only	G, Teflon-lined cap	Cool, 4°C	14 days	40
Pesticides and PCBs	Grab or composite	G, Teflon-lined cap	Cool, 4°C	7 days until extraction, 30 days after extraction	250
pH	Grab only	P,G	Determine onsite	2 hours	25
Phenol	Grab or composite	G	Cool, 4°C, H_2SO_4 to pH <2	24 hours	500
Phosphorus					
Ortho phosphate	Grab or composite	P,G	Filter onsite, cool, 4°C	48 hours	50
Phosphorus, Total	Grab or composite	P,G	Cool, 4°C, H_2SO_4 to pH <2	28 days	50
Radioactivity	Grab or composite	P,G	HNO_3 to pH <2	6 months	1 gal
Silica					
Dissolved	Grab or composite	P	Cool, 4°C	28 days	50
Total	Grab or composite	P	Cool, 4°C	28 days	50
Solids					
Dissolved	Grab or composite	P,G	Cool, 4°C	7 days	100
Volatile Dissolved	Grab or composite	P,G	Cool, 4°C	7 days	100
Suspended	Grab or composite	P,G	Cool, 4°C	7 days	100

TABLE A-1 (continued)

Parameter	Collection technique	Container[a]	Preservation	Holding time[b]	Minimum required volume (mL)
Solids (cont.)					
Volatile Suspended	Grab or composite	P,G	Cool, 4°C	7 days	100
Total	Grab or composite	P,G	Cool, 4°C	7 days	100
Volatile Total	Grab or composite	P,G	Cool, 4°C	7 days	100
Settleable	Grab or composite	P,G	Cool, 4°C	48 hours	100
Sulfate	Grab or composite	P,G	Cool, 4°C	28 days	50
Sulfide	Grab or composite	P,G	Cool, 4°C, 2 ml zinc acetate plus NaOH to pH >9	7 days	500
Sulfite	Grab or composite	P,G	Determine onsite	No holding	50
Surfactants	Grab or composite	P,G	Cool, 4°C	48 hours	250
TOC	Grab or composite	G, Teflon-lined cap	Cool, 4°C, HCl to pH <2	28 days	25
TOX	Grab or composite	G, Amber, Teflon-lined cap	Cool, 4°C, add 1 ml 0.1 M sodium sulfite	7 days	100
Turbity	Grab or composite	P,G	Cool, 4°C	48 hours	100

[a]P = Polyethylene, G = Glass, Pro = Polypropylene

[b]The holding times are those listed in Technical Additions to Methods for Chemical Analysis of Water and Wastes, EPA-600/4-82-055 and Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, EPA-600/4-82-057.

[c]If samples cannot be filtered within 48 hours, add 1 ml of a 2.71% solution of mercuric chloride to inhibit bacterial growth.

[d]Should only be used in the presence of residual chlorine.

Table 8

Container and Preservation Protocol for Soil Analyses

(Laboratories must be certified by the North Carolina DWQ to perform the following methods)

Sample Type/Method	Container	Preservative	Holding Times
EPA 9071 (Oil&Grease)	4-oz glass jar	Cool to 4°C	28 days
EPA 5030/TPH California Method EPA 8260 EPA 8240 EPA 8021 EPA 8015	4-oz glass jar with Teflon-lined septa screw cap	Cool to 4°C	14 days
MADEP VPH	Triplicate VOC vials with Teflon-lined screw caps 60mL vials; add 25g soil **OR** 40-mL vials; add 15g soil	1-mL methanol for every gram of soil; add before or at the time of sampling Cool to 4°C	14 days
EPA 3550/TPH California Method EPA 8270 EPA 8080	8-oz glass jar with Teflon-lined screw cap	Cool to 4°C	Samples must be extracted within 14 days and extracts analyzed within 40 days.
MADEP EPH	4-oz (120-mL) wide-mouth amber glass jar with Teflon-lined screw cap	Cool to 4°C	Samples must be extracted within 7 days and extracts analyzed within 40 days.
Total Metals TCLP Metals	4-oz polyethylene or glass jar	Cool to 4°C	6 months

NOTE: Check with the laboratory that will be doing the analysis for any other requirements.

Table 11

Container and Preservation Protocol for Groundwater Analyses

(Laboratories must be certified by the North Carolina DWQ to perform the following methods)

Sample Type/Method	Container	Preservative	Holding Times
EPA 601/602 EPA 624 SM 6210D SM 6230D MADEP VPH	Duplicate 40-mL VOC vials with Teflon-lined septa screw cap	Add 3 to 4 drops of 1:1 HCl Cool to 4°C	14 days
MADEP EPH	1-L amber glass with Teflon-lined screw cap	Add 5-mL of 1:1 HCl Cool to 4°C	Samples must be extracted within 14 days and extracts analyzed within 40 days
EPA 625	1-L amber glass with Teflon-lined screw cap	Cool to 4°C	Samples must be extracted within 7 days and extracts analyzed within 40 days.
SM 3030C (Metals)	500-mL polyethylene or glass jar	Add 5-mL of 1:1 HNO_3 (to pH<2) Cool to 4°C Submit to lab within 48 hours of collection	3030C prep within 72 hours of collection and analyze within 6 months of prep.

NOTE: Check with the laboratory that will be doing the analysis for any other requirements.

10.3 Groundwater Sample Collection Procedures

A. Water Supply Wells

Water supply wells are sampled to ensure that groundwater used for human consumption is not contaminated. Samples should be collected using the existing pump system and should be collected as close to the well head as possible. Generally this will be the first spigot on the line. Occasionally, water samples may have to be collected from inside the building or house.

contamination on a real time basis. These tests are also considered to be acceptable investigative methods when they are used in a manner which is within their limitations. When evaluating the potential applicability of immunoassay or spectrometric tests, it is recommended that the owner or operator, consultant, and Case Manager consider how the test results will be used, the detection limits, and the detection range (many of these methods have both upper and lower detection limits).

On June 13, 1997, EPA amended its hazardous waste regulations for testing and monitoring. This amendment added new and revised analytical methods as Update III to the Third Edition of the EPA-approved test methods manual "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," EPA Publication SW-846[5-1]. This amendment deleted 14 packed column gas chromatographic methods and replaced them with capillary column methods or methods that provide better resolution, selectivity, and sensitivity.

The UST Technical Regulation specifies that samples must be analyzed by EPA approved methods or methods approved by the board. Significant requirements of Update III that may impact investigation and remediation activities at storage tank sites include:

1. Method 8020A (BTEX) was deleted and replaced with Method 8021B, Halogenated and Aromatic Volatiles by GC;

2. Method 8240B was deleted and replaced with Method 8260B, Volatile Organic Compounds (VOC) by GC/MS;

3. Method 5030 was modified to exclude its use for low-level (<200 ug/kg VOC) soil samples;

4. Method 5035, Closed System Purge-and-Trap Extraction for Volatile Organics in Soil and Waste Samples, which replaces Method 5030 for low-level soils analysis, requires specific techniques that minimize open-air handling of soil samples. This method is designed to be used in conjunction with determinative methods for volatile organic compounds, 8021B, 8260B, and 8015-GRO.

[5-1] Additional information on Update III to SW846 may be obtained from the June 13, 1997, Federal Register.

Table 5-3. Acceptable Analytical Methods for Use at Petroleum Contaminated Sites

Parameter	Analytical Methods	Applicable Medium[1]	"M code" from the 198 UCR Table

BTEX	EPA 503.1 EPA 524.1 EPA 602 EPA 624 SW-846 8021B SW-846 8260B	w w w w w & s w & s	 M0108 M0116 M1361 M1379
TPH Gasoline	California LUFT Method Wisconsin DNR - GRO SW 846 8015b (modified TPH - GRO)	w & s w & s w & s	M0100, M0121 M1000, M1014 M1365, 1367
TPH Diesel, Fuel Oil #1 and #2, Jet Fuel, Kerosene	California LUFT Method Wisconsin DNR - DRO SW 846 8015b (modified TPH - DRO)	w & s w & s w & s	M0101, M0122 M1001, M1015 M1366, M1368
TPH Crude Oil, Fuel Oil #4, #5, and #6, Used Oil, Hydraulic Oil	EPA 413.2 EPA 418.1 Wisconsin TRPH EPA 1664	s w & s s w	 M0123
PAHs/PNAs	EPA 525 EPA 610 EPA 625 SW-846 8100 SW-846 8270C SW-846 8310	w w w w & s w & s w & s	 M0110 M0117 M0143 M0149
MTBE	EPA 602 (modified) SW-846 8021B SW-846 8021B	w w s	M1010 M1371 M1372
Lead	SW-846 7420/7421	s	M1012

[1] Applicable medium refers to the sample matrix that may be analyzed by the subject test method.
"w" refers to an analytical method that may be used to analyze water
"s" refers to an analytical method that may be used to analyze soil

NOTE: Many of the methods listed above for BTEX may be also be used for MTBE

In order to improve the quality of data on which decisions are based, the DEQ Storage Tank Program requires the use of current determinative analytical methods 8021B, 8260B, and 8015-GRO where VOC information is needed. When soil samples will be analyzed for VOCs via 8021B, 8260B and/or TPH by one of the gasoline range methods, DEQ strongly encourages the use of EnCore™ or other EPA approved devices or methods to minimize the loss of volatile constituents after sample collection. Under most conditions, soil will be analyzed for high levels (> 200 ug/kg) fo VOCs. The decision to use any laboratory analytical methods at a specific site should only be made with the guidance and authorization of the Case Manager.

Samples collected during tank closure must be analyzed by an EPA or DEQ approved analytical method that is capable of determining if a release occurred from that tank. Please see Chapter 7 of this manual for additional information about tank closure procedures.

GENERAL CHEMICAL ANALYSIS

Other General Analysis

ANALYSIS	METHOD	SAMPLE REQUIREMENTS & PRESERVATION	MATRIX & CONTAINER	HOLDING TIME
Acidity by TITR	305.1	200 ml/4°C	water - P/G	14 days
Alkalinity by TITR	HACH 8221	200 ml/4°C	water - P/G	14 days
Ammonia-N by ISE	350.3	500 ml/H_2SO_4, 4°C	water - P/G	28 days
Biochemical Oxygen Demand (BOD)	405.1	1000 ml/4°C	water - P/G	48 hours
Carbon Dioxide (CO_2)	HACH 8223	250 ml/4°C	amber G w/septum No headspace	Analyze Immediately
Carbonaceous Biochemical Oxygen Demand (CBOD)	405.1	1000 ml/4°C	water - P/G	48 hours
Chemical Oxygen Demand by SPEC	410.4	125 ml/H_2SO_4, 4°C	water - P/G	28 days
Chlorine, Residual	HACH 8167	250 ml/4°C	water – amber G	Analyze Immediately
Color	110.2	125 ml/4°C	water - P/G	48 hours
Corrosivity (pH meter)	9045	125 ml/4°C 20 gms/4°C	water - P/G soil - P/G	7 days
Corrosivity to Steel by GRAV	1110	1 L/4°C 100 gms/4°C	water - P/G soil - P/G	7 days 7 days
Cyanide, Amenable by SPEC	SM4500 CN^- E&C	500 ml/NaOH, 4°C 100 gms/4°C	water – P soil – G	14 days 14 days
Cyanide, Total by SPEC	SM4500 CN^- E&G	500 ml/NaOH, 4°C 100 gms/4°C	water – P soil – G	14 days 14 days
Extractable Organic Halides (EOX)	9023	50 gms/4°C	soil – G	7 days
Flashpoint, Liquids by Closed Cup	ASTM D-93	125 ml/4°C	liquid – G	7 days
Free Liquids	9095A	200 gms/4°C	soil – P/G	Analyze Immediately
Halides, Total (TOX)	9020	20 gms/4°C	oil – G	7 days
Hardness by ICP/CALC	SM2340B	250 ml/HNO_3, 4°C	water – P	6 months
Hardness by TITR	130.2	250 ml/HNO_3, 4°C	water – P	6 months
Hexavalent Chromium by SPEC	7196 7196M	250 ml/4°C 100 gms/4°C	water - P/G soil – G	24 hours 24 hours
Ignitability by Closed Cup	ASTM D-93	125 ml/4°C 50 gms/4°C	liquid – G soil – G	7 days 7 days
Methylene Blue Active Substances, Surfactants by SPEC	425.1	250 ml/4°C	water - P/G	48 hours
Oil and Grease by GRAV	413.1	2x1000 ml/HCl 4°C	water – G WM	28 days
Oil and Grease by IR	413.2 413.2M	2x1000 ml/HCl 4°C 100 gms/4°C	water - G WM soil - P/G WM	28 days 28 days

GENERAL CHEMICAL ANALYSIS, CON'T

Other General Analysis

ANALYSIS	METHOD	SAMPLE REQUIREMENTS & PRESERVATION	MATRIX & CONTAINER	HOLDING TIME
Ortho Phosphate by SPEC	365.3	100 ml/4°C	water - P/G	48 hours
Percent Moisture by GRAV	SM2540G	50 gms/4°C	soil - P/G	7 days
pH	150.1 9045	125 ml/4°C 20 gms/4°C	water - P/G soil - P/G	Analyze Immediately
Phenolics, Total Recoverable by SPEC	9065	1000 ml/H_2SO_4, 4°C	water - G	28 days
Phosphorus as Total	365.1	100 ml/H_2SO_4, 4°C	water - P/G	28 days
Reactivity (Cyanides/Sulfides) by SPEC/TITR	SW-846 Chapter 7.3	100 gms/4°C	soil - G	7 days
Resistivity	120.1	125 ml/4°C	water - P	28 days
Settleable Solids by GRAV	160.5	1000 ml/4°C	water - P/G	48 hours
Silica (Dissolved) by SPEC	370.1	125 ml/4°C	water - P	28 days
Silicates	200.7	125 ml/4°C	water - P	6 months
Specific Conductance	120.1	125 ml/4°C	water - P/G	28 days
Sulfide by TITR	376.1 376.1M	1000 ml/NaOH, 4°C 100 gms/4°C	water - P soil - G	7 days 7 days
Sulfite by TITR	377.1	100 ml/4°C	water - P/G	Analyze Immediately
Total Dissolved Solids by GRAV	160.1	1 L/4°C	water - P/G	7 days
Total Kjeldahl Nitrogen by SPEC	351.2	250 ml/H_2SO_4, 4°C	water - P/G	28 days
Total Organic Carbon (TOC)	415.1 9060 9060M	250 ml/H_2SO_4, 4°C 250 ml/H_2SO_4, 4°C 50 gms/4°C	water - amber G w/septum water - amber G w/septum soil – G	28 days 28 days 28 days
Total Organic Halides (TOX)	9020	250 ml/H_2SO_4, 4°C	water – amber G	28 days
Total Recoverable Petroleum Hydrocarbons by IR (TPH-IR)	418.1 418.1M	2x1000 ml/H_2SO_4, 4°C 100 gms/4°C	water - G soil - G amber WM	28 days 28 days
Total Solids by GRAV	160.3	1 L/4°C	water - P/G	7 days
Total Suspended Solids by GRAV	160.2	1 L/4°C	water - P/G	7 days
Total Volatile Solids by GRAV	SM2540E	1 L/4°C	water - P/G	7 days
Turbidity	180.1	125 ml/4°C	water - P/G	48 hours

G = Glass **P = Plastic** **WM = Wide Mouth**

DRINKING WATER ANALYSIS, CON'T

Organic Parameters

ANALYSIS	METHOD	SAMPLING REQUIREMENTS & PRESERVATION	CONTAINER	HOLDING TIME
Ethylene Dibromide & 1,2-Dibromo-3-chloropropane	504.1	40 mL w/$Na_2S_2O_3$, 4°C	* Glass with Teflon-lined septum	14 days
Herbicides	515.1	1-Liter w/$Na_2S_2O_3$, 4°C	Amber Glass w/Teflon-lined septum	7 days
PAH: Benzo(a)pyrene	550	1-Liter, 4°C	Amber Glass w/Teflon-lined septum	7 days
Pesticides	508	1-Liter w/$Na_2S_2O_3$, 4°C	Amber Glass w/Teflon-lined septum	7 days
Volatile Organic Compounds (VOC)	524.2	40 - 120 mL w/HCl & Ascorbic Acid **, pH<2, 4°C, no headspace	* Glass w/Teflon-lined septum	14 days

* Governing agency may require trip blanks. Call Client Services if assistance is needed.

** Ascorbic acid is used when collecting *chlorinated* samples. If sample is non-chlorinated or collected di from wellhead, no ascorbic acid is needed.

Swift Creek Environmental, Inc.

Attached is a copy of Swift Creek Environmental Inc.'s State Lead QA/QC Program Manual. It is your responsibility to read and understand the contents of this document. In addition, it is required that all employees attend mandatory scheduled meetings regarding QA/QC training. By signing this document you are agreeing to adhere to Swift Creek Environmental's requirements.

I have received a copy of Swift Creek Environmental, Incorporated Final State Lead QA/QC Program Manual. I have read and understand the enclosed materials. I will attend Mandatory scheduled meetings regarding QA/QC.

_____ _____

Signature Date

cc: Employee File
QA/QC Master Log

Quality Assurance Procedures
Engineering and Environment, Inc.

Quality Assurance/Quality Control Project Plan

(QAPP)

For State Lead Storage Tank Program

Virginia Department of Environmental Quality

April 2000

TABLE OF CONTENTS

1.0 GENERAL APPROACH

1.1 Policy

It is Engineering and Environment, Inc.'s (EEI) policy to ensure the integrity of reported data. This program encompasses all facets of the integrity process, from sampling strategy to the final review and issuance of reports. Management, administrative, statistical, investigative, preventive and corrective techniques are employed to maximize reliability of data. The chain-of-custody of samples and the accompanying quality control procedures are documented and must be traceable. All aspects of the chain-of-custody procedures, including data handling, calculation and reporting must be audited. An error in these areas will render the reported data invalid, regardless of its quality. Specific objectives are:

- To develop and/or put into service rugged methods capable of meeting the sample collection and laboratory's needs for precision, accuracy, sensitivity, and specificity.
- To establish the level of quality of the sampling and laboratory's routine performance.
- To make any changes in the routine methodology found necessary to make it compatible with performance needs.
- To monitor the routine operational performance of the laboratory through an appropriate intra-laboratory program and to provide for corrective actions as necessary.
- To participate in quality evaluation programs with peer firms to achieve and maintain consistent uniform levels of quality.
- To improve and validate field and laboratory methodologies by participation in method validation collaborative tests.

It is EEI's policy to review and update the plan at least annually. The plan is distributed to all EEI personnel and it is essential that the plan be understood and that all policies are followed.

1.2 Purpose

The purpose of this Quality Assurance Project Plan (QAPP) is to provide an orderly assemblage of the detailed and specific procedures and practices that delineate how data of known and accepted quality will be produced. In addition, this QAPP describes the organizational structure and responsibilities of the project team.

To accomplish the various subtasks of the site investigation projects, a readiness review will be performed to assess the availability of adequate procedures, equipment, and properly trained, qualified, and certified personnel. These review requirements will be met prior to the start of project work to assure that identified quality is achieved during the collection, processing, analyzing, and reporting of data. Evaluations of administrative and technical systems approved

for this project will be performed during the project activities and will be modified when necessary to meet regulatory requirements, project management, and other approved requests.

EEI and it's subcontractors will follow this QAPP for all sampling, testing and site investigations.

1.3 Site Specific Plans

The EEI approach is to implement procedures to assure that the precision, accuracy, completeness and representativeness of its data are known and documented. EEI will prepare a written QC Plan covering each project it is contracted to perform. The QC Plan will be designed to achieve the specific data quality goals of each task order. EEI will follow the QA/QC checklist shown in Figure 1 to develop the QC plan for each project.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

Operational responsibilities are those involving execution and the direct management of the technical and administrative aspects of this contract. The following responsibilities have been assigned:

Assignment	**Name**
Project Manager	Peter Mathews, P.E.
Corporate QA/QC Manager	Dewitt Davis, C.I.H.
Health and Safety Officer	Bruce Salta
Staff Scientists	
Hydrogeologist	B. Dwight Hunt
Geologist	Dave Cleland, P.G.
Chemist	Diane Nash
Technician	Jim Madson

The organizational chain of command is shown in Figure 2.

2.1 Project Manager

Project Manager responsibilities include providing data of acceptable and known quality, procurement document control, analysis and design of tests, and review and approval of all project tasks.

In addition, the EEI Project Manager identifies the lists of project documents and records controlled and generated by the project tasks, procedures, and support activities.

The Project Manager will also be responsible for directing all field activities for EEI and its subcontractor(s) while on the facility. Duties will include:

- Daily health and safety briefings prior to start of work.

QA/QC CHECKLIST

QA MANAGEMENT PROGRAM - *integrates management and technical practices; ensures project elements and activities comply with regulatory guidelines.*

QA PROJECT PLAN - *Overall plan for activities performed at each stage of the project.*

Project description - *Defines project goals and methods to achieve those goals.*

Project organization; personnel responsibilities and qualifications

- Organizational flow diagram and/or tables

Data quality objectives

- Data quality objectives summary table

Sampling procedures

- Sampling plan outlining all methods, procedures, and equipment
- Checklists for field equipment, sample container preparation, sample preservation, etc.
- Alteration checklist

Sample custody and documentation - record all events associated with a sample

- Sample labels
- Tracking report forms (field and laboratory)
- Chain of custody forms
- Station location log

Calibration procedures

- Procedures used to assure field and laboratory equipment are calibrated and functioning properly

Standard operating procedures - *written descriptions of routine methods*

Data validation, reduction, and reporting - *procedures used to accept or reject data after collection*

Chemical Quality Control - *procedures to be used to demonstrate precision, accuracy, comparability, completeness, and representativeness*

Performance and system audits - *an independent evaluation of field and laboratory procedures*

- Systems Audit Checklist

Facilities - *a complete, detailed description of physical layout of laboratory with the areas defined where each test will be performed*

Preventive maintenance procedures and schedules - *procedures and schedules to be used to ensure equipment will be maintained in proper working order*

- Records of calibrations
- Records of corrective actions applied

Specific routine procedures to be used to assess data precision, accuracy, and completeness - *calculations, equations, and type of samples to assess precision, accuracy and completeness of data*

Corrective action - *identification of nonconformance events*

- Records of corrective actions applied
- Alteration checklist

Physical and chemical analyses - *procedures to be used to ensure analyses of seawater, sediment, and tissues meet acceptable criteria*

Biological analyses - *procedures to be used to ensure the condition of test animals and results of biological tests meet acceptable criteria*

- Reference Toxicant/Test Organism Control Charts

QA reports to management - *a description of methods to be used for periodic reporting to management*

Figure 1. Quality Assurance/Quality Control Checklist (U.S. EPA / U.S. Army Corps of Engineers 1993)

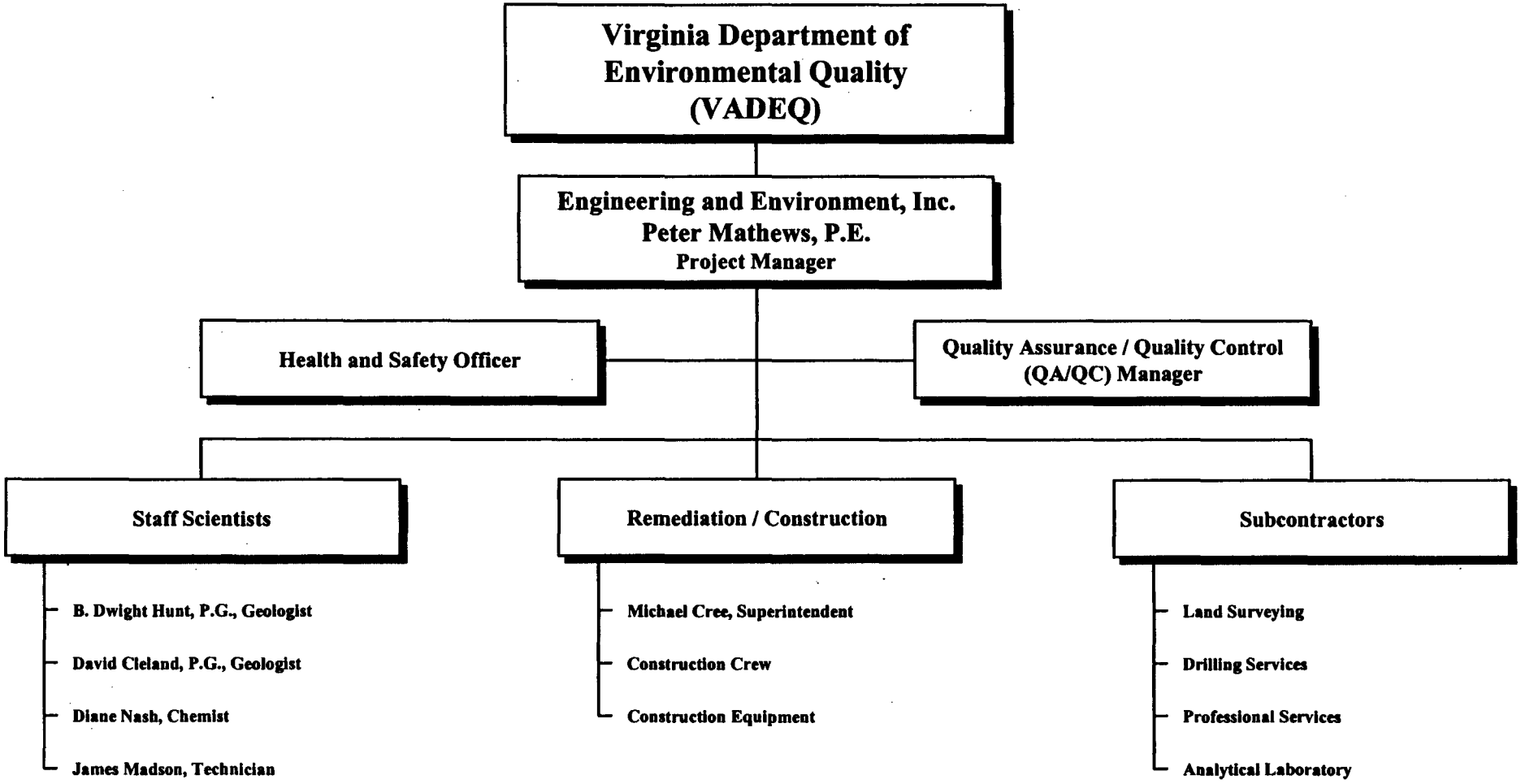


Figure 2. Organizational Chain-of-Command

- Issuing work assignments.
- Training personnel and verifying that field personnel are properly trained.
- Coordination between the facility and EEI for access, permits, supplies, and shipping.
- Performing daily QA/QC checks of field data and logbooks for completeness and accuracy to detect and correct errors in a timely manner.
- Controlling documents and data and maintaining project files.
- Ensuring the chain-of-custody is maintained.

2.2 Staff Scientists

Staff Scientists from EEI will include personnel qualified in one or more of the following technical fields:

- Chemist
- Hydrogeologist
- Geologist
- Field Technician

All personnel will be qualified and properly trained in the work tasks assigned. Records of training and qualifications will be maintained by the Project Manager. The number and type of personnel on the site will vary according to the work schedule. The following lists the technical personnel required for each field task:

Task	Personnel Required
Groundwater Sampling	Hydrogeologist/Chemist/Field Technician
Surface-Water Sampling	Hydrogeologist/Chemist/Field Technician
Soil Sampling	Geologist/Field Technician
Sediment Sampling	Chemist/Hydrogeologist/Field Technician
Boring Logs	Geologist
Water-Level measurements	Hydrogeologist
Well-Location Survey	Land Surveyor
Monitoring-Well Installation	Hydrogeologist/Geologist/Field Technician

2.3 Drilling Operations

A Geologist will be responsible for field management of all subsurface drilling activities. Duties will include monitoring of drilling activities for compliance with requirements and procedures,

management of drilling personnel while on the site, supervision of all monitoring well installation and subsequent sampling activities for compliance with procedures established for the site. EEI personnel will be responsible for assuring that work is in accordance with all permits and access agreements.

2.4 QA/QC Manager

A QA/QC Manager from EEI will be assigned to assist in planning, readiness review, value engineering and quality assurance audits and will overview field investigation, sample analysis, and data evaluation. The QA/QC Manager will provide support to the EEI Project Manager for the project, verify that Quality Assurance requirements have been included in planning documents and that quality control and assurance is implemented during the project activities.

The QA/QC Manager is subordinate only to the Project Manager. The QA/QC Manager is assimilated into the organization, reporting to the lowest level at which s/he can be effective and unbiased in objectively serving the needs of the program. Under no circumstances will the QA/QC Manager be made subordinate to an individual responsible to generate measurement data.

Responsibilities of the QA/QC Manager

The QA/QC Manager is responsible for the conduct of the QA/QC program and for taking or recommending measures to ensure the fulfillment of the quality objectives of management and the carrying out of QA/QC policies in the most efficient and economical manner commensurate when ensuring continuing accuracy and precision of data produced.

Authority and responsibilities of the QA/QC Manager include:

- Development and carrying out the quality assurance program, including statistical procedures and techniques, which will help EEI to meet quality standards at minimum cost; and to advise and assist management in the installation of such a program.
- Monitoring QA/QC activities of EEI to determine conformance with authorize policy and procedures and with sound practice; and making appropriate recommendations for correction and improvement as may be necessary.
- Seeking out and evaluating new ideas and current development in the field of quality assurance and recommending means for their application whereever advisable.
- Advising management in reviewing technology, methods, and equipment, with respect to quality aspects.
- Advising the Purchasing Section regarding quality of purchased materials, instruments, reagents, and chemicals.
- Recommending packaging materials and procedures.
- Performing related duties as assigned.

Qualifications of the QA/QC Manager

Well-qualified and properly trained QA/QC Manager is a key aspect of satisfactory performance of the QA/QC program. Though good facilities and equipment are essential, they are of little value without well-trained personnel. Therefore, EEI has established adequate qualifications for the QA/QC Manager and provides an ongoing training program to develop and maintain his abilities to carry out the methods and procedures of the field data collection and the laboratory. In addition, the person should be knowledgeable in all aspects of chemistry and hydrology to facilitate general communication with the project staff. The proposed QA/QC Manager, Dewitt Davis, C.I.H., has a bachelor's degree in chemistry and a master's degree in Engineering Management. He has taken many post-graduate courses in sampling, quality assurance and industrial hygiene. He has over 20 years of experience in laboratory quality control procedures and field experience to conduct sampling programs at hazardous waste sites.

2.5 Health and Safety Officer (HSO)

The HSO has overall responsibility for development and implementation of the health and safety procedures. She/he also shall approve any changes to this program due to modification of procedures or newly proposed site activities.

The HSO will be responsible for the development of new company safety protocols and procedures necessary for field operations and will also be responsible for the resolution of any outstanding safety issues, which arise during the conduct of the site work. Health and safety related duties and responsibilities will be assigned only to qualified individuals by the HSO. Before personnel may work on-site, currentness of acceptable medical examination and acceptability of health and safety training must be approved by the HSO.

The HSO will be present on-site during the conduct of all level B or high-hazard level C field operations and will be responsible for all health and safety activities and the delegation of duties to the H&S staff in the field. Where the site is identified as low-hazard level C or level D, the HSO may direct the site health and safety efforts through an assistant health and safety officer. S/he may direct or participate in the downrange activities as appropriate when this does not interfere with his primary HSO responsibility. The HSO has stop-work authorization, which s/he will execute upon his determination of an imminent safety hazard, emergency situation, or other potentially dangerous situations, such as detrimental weather conditions. Authorization to proceed with work will be issued by the HSO after such action. The HSO will initiate and execute all contact with support facilities and personnel when this action is appropriate.

3.0 INTERNAL DOCUMENT MANAGEMENT PROCEDURES

3.1 Quality Control Objectives

Accuracy of sampling and laboratory measurements is a central concern of EEI field and laboratory personnel. We devote considerable technical and administrative effort to ensure that our numbers are as accurate as possible. The objectives of any particular program directly affect all aspects of sampling and analysis. Therefore, the determination of the work objectives must

take place before a sampling program is established. These objectives can take the form of satisfying regulatory agencies, testing the effectiveness of a research project, or standardizing a control process.

3.2 Data Quality

The purpose of this section is to provide quality assurance for data measurement by assuring the accuracy of parameter identification and quantification. This is necessary to assure data-quality objectives specified for each site in the Sampling and Analysis Plan are met.

Accuracy of Parameter Identification

Personnel will state precisely what was measured in the field or laboratory and will prove its identity through field testing and laboratory analysis of soil, gas, and water samples. The data types for each site are identified for the project.

Data Types

The following data will be collected from sample/measurement types identified for the project:

- Volatiles
- Semi-Volatiles
- Metals (filtered)
- Anions
- pH and Eh
- Conductivity
- Temperature
- Water-Level Measurements
- Well Hydraulic Test Data
- Water-Table Map Contours
- Organic Vapor Flux
- Organic Compound Identification
- Benzene, Toluene, Ethylbenzene, and Xylene (BTEX)
- Benthic Organisms

Acceptance Criteria

Acceptance criteria for laboratory analysis are specified in EPA SW-846.

Accuracy of Quantification

Quality-control procedures that reduce and maintain random and systematic errors within tolerable limits will be used. Appropriate methods, adequate calibrations, and proper usage of equipment to provide accurate measurements will be employed.

Good analytical methods related to reagent control, cleaning operations, and general operations such as weighing, preparing solutions, preservation of samples, and recording and processing of

data will be employed. Documentation of all operations and records necessary to support the measurements and identify assignable causes in the event of measurement problems or to improve the accuracy will be kept. Proper maintenance of facilities and equipment will be performed, and the project personnel selected for measurement of data will maintain the educational requirements and skill level needed through continuing education and training in the techniques used.

Data Precision and Bias [1]

Repetitive measurements of analytical samples will be made by the use of replicate samples to judge precision of each measurement process. Analysis of spiked and blank sample data will be performed by the laboratory to provide a measure of the bias of each test method. Field measurements will be checked by repetitive measurements of a standard. Then the bias will be determined. When only two results are obtained under conditions of repeatability [r, a quantitative expression of the random error associated with a single operator in a given laboratory obtaining replicate results with the same apparatus under constant operating conditions on identical material within a short period of time], [2] and the difference is equal to or less than the repeatability of the method, the operator may report the average of the two results as being applicable to the sample tested. An estimate of the standard deviation, S, is obtained from the average range, R, of duplicate analyses by dividing by 1.128, the proper factor for acquiring a standard deviation estimate from ranges derived from duplicates:

$$S = R/1.128$$

Reference: ASTM D4210-83, Standard Practice for Intralaboratory Quality Control Procedures and a Discussion of Reporting Low-Level Data.

Data reports will indicate whether or not results fall within the 2 S limits calculated.

1 ASTM Standard E177, Standard Practice for Use of the Terms Precision and Bias in ASTM Methods states that approximately 95 percent of individual tests results can be expected to differ in absolute value from their average values by less than 2 standard deviations

2 ASTM Standard D3244-77 (Reapproved 1983), Standard Practice for Utilization of test Data to Determine Conformance With Specifications.

Data Completeness

Data will be scientifically valid and of known and acceptable accuracy and precision. The parameters of interest for the project will be listed in the project specific Sampling and Analysis Plan. Methods of data collection will also be identified in the Sampling and Analysis Plan. The methods described involve the collection of discrete samples for testing in the field and for analysis in the laboratory. Data completeness will be 95 percent or better for sample collection. Chain-of-custody records will be created at the point of sampling to accompany the samples throughout their storage, handling, shipping, receipt, analysis, and data reporting.

Data Representativeness

The data highly representative of the project sites will be collected and analyzed using the field sampling techniques and analytical procedures described in the project specific Sampling and Analysis Plan. Deviations from these procedures will be documented on the Field Variance logs.

Data Comparability

Data comparability will be achieved by taking samples in accordance with standard accepted procedures used on previous studies, analyzing samples by nationally recognized or equal methods, reporting test results in international units (SI), and applying consistent QC/QA controls.

3.3 Sampling Procedures

Obtaining representative samples and then maintaining the integrity of their constituents is an essential part of any monitoring or enforcement program. Standardization of the analytical techniques has been established to a high degree but the results of analysis are only as good as the sampling procedures and the sample preservation. EEI uses the best techniques currently available for sampling and sample preservation. The choice of the most appropriate and effective procedures is made for each specific application. In order to achieve the overall objectives of a sampling program, the number of samples, frequency of sampling, and the measurements required all have to be addressed.

In sampling, the objective is to remove a small portion of an environment that is representative of the whole. Obviously improper sampling will give erroneous results. Prior to analysis, the constituents of the sample must be maintained in the same condition as when the sample was collected. The length of time that the sample will remain stable depends on the preservation method.

Statistical Approach to Sampling

Assurance of representative sampling, both as to site selection and frequency, requires a survey design which provides: A sufficient number of sampling locations; Appropriate types of samples; and Adequate frequency of sampling. This will provide a valid representation of the characteristics being assessed and should ensure that survey objectives are met. EEI follows those procedures outlined in the *Handbook for Sampling and Sample Preservation of Water and Wastewater*, EPA-60014-76-049.

Sampling and Analysis

EEI will prepare a sampling and analysis (S&A) plan for each project. This plan will include information on:

- Sample collection;
- Sample preservation and handling;

- Chain-of-custody control;
- Analytical procedures; and
- Field and laboratory quality assurance/quality control.

Sample Collection

The sampling and analysis plan will include provisions for measurement of static water elevations in each groundwater well and surface waters prior to each sampling event. The S&A plan will specify the device to be used for water level measurements, as well as the procedure for measuring water levels. Whenever nondedicated equipment is used procedures will be instituted to ensure that the sample is not contaminated. Equipment will be constructed of inert materials and decontaminated prior to use at another location. The S&A plan will include provisions for detecting immiscible contaminants (i.e., "floaters" and "sinkers") where they would not be detected in an aqueous phase if this type of waste is known to be present at the facility.

The water standing in a well prior to sampling may not be representative of in-situ groundwater quality. Therefore, EEI will remove the standing water in the well and filter pack so that formation water can replace the stagnant water. The S&A plan will include detailed, step-by-step procedures for evacuating wells. The equipment to evacuate wells will also be described. When purging equipment must be reused, it will be decontaminated, following the same procedures required for the sampling equipment. Clean gloves will be worn by the sampling personnel. Measures will be taken to prevent surface soils from coming in contact with the purging equipment and lines. Purged water will be collected and screened with photoionization or organic vapor analyzers, pH, temperature, and conductivity meters. If these parameters and facility background data suggest that the water is hazardous, it will be drummed and disposed properly.

The technique used to withdraw a ground-water sample from a well will be selected based on a consideration of the parameters to be analyzed in the sample. To ensure the groundwater sample is representative of the formation, it is important to minimize physically altering or chemically contaminating the sample during the withdrawal process. In order to minimize the possibility of sample contamination, EEI will:

- Use only fluorocarbon resin or stainless steel sampling devices; and,
- Use dedicated samplers for each well.

When collecting samples where volatile constituents or gases are of interest using a positive gas displacement bladder pump, pumping rates will not exceed 100 milliliters/minute.

Constituents of the parameters which are physically or chemically unstable will be tested either in the borehole using a probe (in-situ) or immediately after collection using a field test kit. Examples of unstable elements or properties include pH, redox potential, chlorine, dissolved oxygen, and temperature. Although specific conductivity (analogous to electrical resistance) of a substance is relatively stable, this characteristic will be determined in the field. EEI will complete the calibration of any in-situ monitoring equipment or field-test probes and kits at the beginning of each use, according to the manufacturers' specifications and consistent with *Test*

Methods for Evaluating Solid Waste - Physical/Chemical Methods (SW-846), 2nd. Edition, 1982.

Equipment Decontamination/Cross-Contamination Prevention

Equipment and tools used to sample and test field materials will be decontaminated prior to use, between uses, and at the end of the activity to prevent cross-contamination of samples. The project specific Sampling and Analysis Plan will describe the decontamination procedure and precautions.

Field Variance Logs

A notation must be made on the Field Variance Log (Figure 3) whenever a sample is taken that does not fall within the specified requirements of the field sampling technique; the shipping, handling, and storage requirements; or equipment decontamination and cross-contamination prevention efforts. Comments describing the variance will be used during sample processing and data evaluation to assess the use of associated results and validity of the data.

Sample Preservation and Handling

Many of the chemical constituents and physiochemical parameters that will be measured or evaluated are not chemically stable, and therefore sample preservation is required. *Test Methods for Evaluating Solid Waste - Physical/Chemical Methods* (SW-846) includes a discussion by analyte of the appropriate sample preservation procedures. In addition, SW-846 specifies the sample containers that should be used for each constituent or common set of parameters. EEI will follow SW-846 and identify in the S&A plan what preservation methods and sample containers will be employed. Each sampling and analysis plan will also detail all procedures and techniques for transferring the samples to either a field or off-site laboratory.

Care will be taken with samples acquired in the field to assure that they are handled in accordance with the Health and Safety Plan requirements for preventing contamination of field personnel and in accordance with the approved field sampling techniques for minimal contamination of the samples. Samples will be immediately tested in the field for the physical and chemical parameters of interest, or procedurally transferred to a specified container for conditioning or storage at reduced temperatures to reduce loss of the measurable quantities present, prior to subsequent packaging and shipping to the laboratory for analysis.

Sediment will be stored at 4°C and tested within 6 weeks from collection date (preferably 2 weeks). Whenever possible, samples will be stored with zero headspace or under nitrogen gas. Samples will be rehomogenized just prior to testing.

Sample Seiving

Seiving of test material prior to testing will be done in accordance with the test protocols. If seiving is required, all sediments (including reference, control, and test) will be press seived

Field Variance Log

(See reverse side for instructions)

1. Project _____ 2. Project Site _____

3. Variance No.	4. Variance Date / /	5. Initiated by (Signature)	6. Reference Document	7. Description of Variance	8. Corrective Action (If applicable)

Distribution: Project File Project Manager QA Coordinator

Figure 3. Example of Field Variance Log

Instructions

Any activity that does not meet the specified requirements of field activities must be noted on this Field Variance Log, for example:

- Sampling technique
- Shipping, handling, and storage of samples, equipment, or instruments
- Equipment decontamination and cross-contamination prevention efforts
- Drilling
- Procedure noncompliance or deviations associated with project activities

Informational copies of completed Field Variance Logs shall be sent to the Project Manager (PM) and Quality Assurance Coordinator (QAC) by the Project Team Leader. *(Note: Comments describing the variance will be used during data evaluation to assess the results and validity of the data.)*

(1) Project name or title

(2) Name or title of the project site (if applicable)

(3) Sequential numbering of the variance reported

(4) Date the variance(s) occurred

(5) Legal signature of the initiator of the Field Variance Log item

(6) Reference the procedure or document that was deviated

(7) Briefly describe the variance(s) and/or reference where the variance is fully described

(8) Describe the immediate corrective action taken (if applicable)

(9) Distribution (responsibility of Project Team Leader)

Figure 3. Example of Field Variance Log, continued

proir to testing. In most cases, a 0.5-mm screen size is sufficient for removing predators and competitors.

Sample Subdivision, Homogenization, and Composting

Sediments will be homogenized to consistent color and texture prior to testing. Clean, noncontaminating containers and implements will be used to handle and store sediments. Suggested materials are stainless steel, Teflon, or Lexan. These containers will be specified in toxicological testing methods.

Chain-of-Custody

EEI will describe a chain-of-custody program in the S&A plan. An adequate chain-of-custody program will allow for the tracing of possession and handling of individual samples from the time of field collection through laboratory analysis. The standard chain-of-custody forms will be provided by the laboratory. The chain-of-custody program will include:

- Sample Labels, which prevent misidentification of samples;
- Sample Seals, to preserve the integrity of the sample from the time it is collected until it is opened in the laboratory;
- Field Logbook, to record information about each sample collection during the monitoring program;
- Chain-of-Custody Record, to establish the documentation necessary to trace sample possession from the time of collection to analysis;
- Sample Analysis Request Sheets, which serve as official communication to the laboratory of the particular analysis(es) required for each sample and provide further evidence that the chain of custody is completed; and
- Laboratory Logbook and analysis notebooks, which are maintained at the laboratory and record all pertinent information about the sample.

Sample Labels and Placards

Labels used for samples taken in the field and placards for transportation will be in accordance with EEI and subcontractor-approved procedures, and the U.S. Department of Transportation (DOT) Code of Federal Regulations Title 49 CFR Parts 171-179, and U.S. Environmental Protection Agency (EPA) regulations Title 40 CFR Part 263.

Sample Security

Field samples must be stored in environmentally, or when allowable, non-environmentally controlled and locked containers or buildings when they are out of the direct control of the

responsible custodian of the sample. Laboratory pre-analysis sample storage requirements include environmental controls, where necessary.

Internal Chain-of-Custody

Tracking procedures will demonstrate that the sample that was collected is the sample that was tested. This will be accomplished through the use of standard sample tracking (chain-of-custody) forms. Examples of these forms are presented in Figures 4 and 5.

Analytical Procedures

The S&A plan will describe in detail the analytical procedures that will be used to determine the concentrations of constituents or parameters of interest. These procedures will include suitable analytical methods as well as proper quality assurance and quality control protocols. The required precision, accuracy, detection limits, and percent recovery (if applicable) specifications will be clearly identified in the plan.

Field QA/QC Program

The S&A plan will provide for the routine collection and analysis of two types of QC blanks: trip blanks and equipment blanks. Each time a group of bottles is prepared for use in the field, one bottle of each type (e.g., glass, fluorocarbon resin, polyethylene) will be selected from the batch and filled with deionized water. The bottles filled with the blank will be transported to the sampling location and returned to the laboratory in a manner identical to the handling procedure used for the samples. These trip blanks will be subjected to the same analysis as the water samples. The concentration levels of any contaminants found in the trip blank will not be used to correct the sample water data. The contaminant levels will be noted, and if the levels are within an order of magnitude when compared to the field sample results, EEI will resample the ground/surface water.

Equipment Blank - To ensure that the nondedicated sampling device has been effectively cleaned, the device will be filled with Type II reagent grade water or Type II reagent grade water pumped through the device, transferred to sample bottle(s), and returned to the laboratory for analysis. A minimum of one equipment blank for each day that ground-water monitoring wells are sampled will be tested.

All field equipment that EEI will use will be calibrated prior to field use and recalibrated in the field before measuring each sample. EEI will follow the QA/QC guidelines provided in Figures 6 and 7 and Tables 1 and 2.

...Oak Building • Suite 318 • Virginia Beach, VA 23462
T 757-490-4653 • FAX: 499-3499

Project:				**Turnaround Time**											
Project #				**# of Containers**											
LAB: GPL Laboratories				**Container Type**											
Address: 202 Perry Parkway				**Preservative**											
Gaithersburg, Md 20877				**Analysis**											
POC/Tel: Paul Ioannides – 301-926-6802															
Send Results To:															
Sampled By:															
Sample ID	**Date (99)**	**Time Sampled**	**Sample Matrix**												**Remarks**

Relinquished By:	Date	Time	Received By	Data	Time
Relinquished By:	Date	Time	Special Instructions		
Received Temp:	Lab Comments:				

Figure 4. Field Chain-of-Custody Form (EEI 1995)

CHAIN-OF-CUSTODY RECORD

PROJECT:	SAMPLERS: *(Signature)*

				SAMPLE MATRIX				
SAMPLE NO.	SITE	DATE	TIME	WATER	SOIL	GAS	NO. CONTAINERS	REMARKS

RELINQUISHED BY: *(Signature)*	RECEIVED BY: *(Signature)*	DATE/TIME
RELINQUISHED BY: *(Signature)*	RECEIVED BY: *(Signature)*	DATE/TIME
RELINQUISHED BY: *(Signature)*	RECV'D BY MOBILE LAB FOR FIELD ANAL: *(Signature)*	DATE/TIME

DISPATCHED BY: *(Signature)*	DATE/TIME	RECEIVED FOR LAB BY: *(Signature*	DATE/TIME

METHOD OF SHIPMENT

Figure 5. Laboratory Chain-of-Custody Form

FIGURE 6. LABORATORY REPORTABLES

(GENERAL INFORMATION)

1. Results of sample analyses.
2. Parameters of interest.
3. Method of analysis.
4. Detection limits of analysis.
5. Master list of laboratory tracking ID numbers correlated to field sample ID numbers and sample analysis batch identification to correlate QA samples to sample analysis batch.
6. Sample collection date.
7. Sample receipt date.
8. Sample preparation/extraction date.
9. Sample analysis date.
10. Copy of COC form signed by laboratory sample custodian.
11. Narrative summary identifying and QA or sample problems encountered, required sample manipulations (dilutions),and the corrective action taken.

FIGURE 7. EPA - DEFINED QUALIFIERS

U - Indicates compound was analyzed for but not detected. The sample quantitation limit must be corrected for dilution and for percent moisture. For example, 10 U for phenol in water if the sample final volume is the protocol-specified final volume. If a 1 to 10 dilution of extract is necessary, the reported limit is 100 U. For a soil sample, the value must also be adjusted for percent moisture. For example, if the sample had 24% moisture and a 1 to 10 dilution factor, the sample quantitation limit for phenol (330 U) would be corrected to:

$$\frac{(330\ U)}{D} \times df \qquad \text{where } D = \frac{100 - \%\ \text{moisture}}{100}$$

and df = dilution factor

For example, at 24% moisture, $D = \frac{100 - 24}{100} = 0.76$

$\frac{(330\ U)}{.76} \times 10 = 4300$ U, rounded to the appropriate number of significant figures

J - Indicates an estimated value. This flag is used under the following circumstances; 1) when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, 2) when the mass spectral and retention time data indicate the presence of a compound that meets the volatile and semi-volatile GC/MS identification criteria, and the result is less than the CRQL but greater than zero. Note: the "" code is not used and the compound is not reported as being identified for pesticide/Aroclor results less than the CRQL, if the technical judgment or the pesticide residue analysis expert determines that the peaks used for compound identification resulted from instrument noise or other interferences (column bleed, solvent contamination, etc.). For example, if the sample quantitation limit is 10 ug/L, but a concentration of 3 ug/L is calculated, report is at 3J. The sample quantitation limit must be adjusted for dilution as discussed for the U flag.

B - This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action. This flag must be used for a TIC as well as for a positively identified target compound.

E - This flag identifies compounds whose concentrations exceed the calibration range of the GC/MS instrument for that specific analysis.

D - This flag identifies all compounds identified in an analysis at a secondary dilution factor. If a sample or extract is re-analyzed at a higher dilution factor, as in the "E" flag above, the "DL" suffix is appended to the sample number.

Table 1. Field QA/QC Guidelines			
SAMPLE TYPE	PURPOSE	COLLECTION	DOCUMENTATION
A. Blank field 1/day/matrix/fraction	To check cross contamination of samples during sampling	Collect last reagent water rinse of sampling equipment before going to next sample. Use water containers.	Assign separate sample number. Identify samples in field log.
B. Blank, equipment (Rinsate or Decon) 1/day/matrix/fraction	To check field decontamination (DECON) procedures	Collect last reagent water rinse of sampling equipment before going to next sample. Use water containers.	Assign separate sample number. Identify samples in field log.
C VOA Trip Blank** 1/day of VOA sampling	Check contamination from field to laboratory	Use HPLC Grade (carbon free) water. (Zero head space). transport to field from lab.	Assign separate sample number. (Same sample number to QA LAB) Identify samples in field log.
D. Field Duplicate 1/10/matrix/fraction	Check laboratory and field procedures. Used for determination of precision, RPD.	Collect two collocated samples from areas which are known or suspected to be contaminated.	Assign separate sample number, submit *blind to lab. Identify samples in field log.
E. MS/MSD 1/20/matrix/fraction	Used for determination of accuracy, % REC, and for determination of precision RPD.	Collect triple volume for water organics. Collect double volume for inorganic water samples. Include in the first shipment homogenized for all fractions except VOA at laboratory.	Assign separate sample number. Identify the samples as LAB QC n the TR. Identify samples in field log.
1. Inter-lab split sample (QA split) 1/10/matrix/fraction	External performance audit	Collect one sample. Homogenize and split. Collect from areas of known contamination. Collect two collocated samples for VOA.	Assign separate sample number. Same sample number to QA LAB. Keep *blind from contract lab. Identify samples in field log.
2. Field matrix Spike Frequency may vary	External performance audit	Collect two samples. One sample will be spiked and split. One sample will be split, Aqueous only. Collect from areas of known contamination.	Assign separate sample number. Same sample number to QA LAB. Keep *blind from contract lab. Identify samples in field log.
3. Blind Blank Frequency may vary	External performance audit	Collect two samples. One sample will be spiked and split. One sample will be split, Aqueous only.	Assign separate sample number. Same sample number to QA LAB. Keep *blind from contract lab. Identify samples in field log.
4. Performance Evaluation Frequency may vary	External performance audit	Submit one sample to contract lab.	Assign separate sample number, submit *blind to lab. Identify samples in field log.

*Blind; the lab has no indication of the actual composition or concentration of the contaminant. In contrast, the laboratory knows the exact composition and concentration of a matrix spike.

**Trip blanks are to prepared fresh at the originating lab. They are to be prepared with HPLC grade water. They are to be shipped from the lab to the field and back to the respective labs. They are to be packed inside the plastic bags that contain the VOA field samples.

Table 2. Comparative Levels of Data Deliverables

Field QC Samples and Lab Reportables	I	II	III	IV (6)
VOA Trip Blank	X	X	X	X
Field Blank (VOA, SV)	X	X	X	X
Field Duplicate	No	X	X	X
Sampler Reinstate Blank	X	X	X	X
LAB REPORTABLES				
General (+)	X	X	X	X
A. INORGANICS				
Conc. of Cal. Curve Stds.	No	No	X	
Initial Calib. Verification Std. (ICVS)	No	X	X	
Continuing Cal. Verification Std. (CCVS)	No	X	X	
Lab. Control Sample (LCS)	No	(1)X	(1)X	
Reagent Water Blank Spike (RWBS)	*	*	*	
Method (Prep) Blank	X	X	X	
Calibration Blank	No	X	X	
Interference Check Sample (ICS)	No	No	X	
Dilution Check Sample	No	No	X	
Matrix Spike (Digested)	(2)X-B	X-B	X-S	
ɔ. Duplicate	(3)X-B	(4)X-B	(5)X-B	
Matrix Spike Duplicate (MSD)	No	No	X	
Analytical Spike (Post Digested) Furnace	No	No	X-S	
RWBS Duplicate	*	*	No	

(1), (2) or RWBS
(3), (4) Or RWBS Duplicate
(5) Sample Specific MSD
(6) CLP Reportable Format
(*) Alternate Control Sample
(+) Master List Narrative
B, Batch Specific
S, Sample Specific

Table 2. Comparative Levels of Data Deliverables, continued

Field QC Samples and Lab Reportables	I	II	III	IV (6)
VOA Blank	X	X	X	
SV Blank	X	X	X	
Trip Blank	X	X	X	
RWBS	X	X	X	
RWBS Duplicate	X	X-A	X-A	
Matrix Spike	No	X-B	X-S	
MSD	No	*	X-S	
Lab Duplicate	No	(7)X-B	(8)X-S	
Surrogates	No	X	X	
Sample Chromatograms	No	No	X	
2. GC/MS				
BFB, DFTPP	No	No	X	
Initial-Continuing Calibration (VOA, SV)	No	No	X	
Blank (VOA, SV)	X	X	X	
Trip Blank	X	X	X	
Matrix Spike	No	X-B	X-S	
MSD	No	X-B	X-S	
Surrogates	No	X	X	
RIC (Chromatograms)	No	No	X	
ISTD Area and RT	No	No	X	
TIC	No	No	X-R	
RWBS	X	X	X-M	
RWBS Duplicate	X	X	X-M	
Lab Duplicate	No	(OP)	X	

A, If Lab Dup. or MSD not OK
R, If required
M, If MS or MSD not OK
RIC, Reconstructed Ion Chromatograms
(6) CLP Reportable Format
(7) Or MSD
(8) If MSD not analyzed
(OP) Optional
(*) Alternate Control Sample

Table 3. Summary of Quality Control Procedures

Type of Analysis	Minimum Controls
Qualitative	One Blank Two Calibration standards
Semi-quantitative	One Blank Two Calibration standards 5% Duplicate/samples 5% Spike/samples
Quantitative	One Blank Initial standard curve (beginning of the program) Two Calibration standards 5% Duplicate/samples 5% Spike/samples One Performance evaluation sample

3.4.2 Laboratory QA/QC Program

The S&A plan will provide for the use of standards, laboratory blanks, duplicates, and spiked samples for calibration and identification of potential matrix interferences. EEI will use adequate statistical procedures (e.g., QC charts) to monitor and document performance and implement an effective program to resolve testing problems (e.g., instrument maintenance, operator training). Data from QC samples (e.g., blanks, spiked samples) will be used as a measure of performance or as an indicator of potential sources of cross-contamination, but will not be used to alter or correct analytical data.

Calibration Procedures and Frequency

Requirements to calibrate tools, gauges, instruments, and other devices used that affect or evaluate the quality of activities or items are identified in the technical procedures used to obtain data. The calibration frequency of devices used by EEI and subcontractors will be standardized in accordance with EPA SW-846 (Third Edition, November 1986) requirements.

4.0 DATA VALIDATION

The analytical procedures used by EEI and subcontractors to perform the analyses are EPA-specified. All personnel who perform these procedures are trained, qualified, and experienced in the methods used. Their proficiency to perform the procedures is continuously evaluated.

4.1 Data Reduction and Reporting

Analytical data from the laboratory will be evaluated by the Project Manager for conformance to the project requirements for accuracy, precision, and completeness. Qualifications for approval, if appropriate, will be addressed in the case narratives. In addition to the summarized forms for precision and accuracy of the analyses (EPA Form 1320-6), the laboratory will provide the analytical results for blanks, duplicate, and the recovery data for matrix and surrogate spikes to the Project Manager.

Raw data from field measurements and sample collection activities that is used in project reports will be appropriately identified and appended to the report. Where data have been reduced or summarized, the method of reduction will be documented in the report.

Documentation will be provided to fully interpret the data, as well as protect it against scientific challenges. Field variance logs, internal review records, field and laboratory records of tests and analyses, field logs, Chain-of-Sample Custody records, reports, and computer files and codes, programs, and printouts will be designed to eliminate errors during data entry and reduction. Calculation steps are described in the technical and analytical procedures and software listings. Routine data-transfer and entry-validation checks are performed.

Laboratory Notebooks, No-data Entries, Abbreviations, and Corrections

Standardized data recording forms and entry formats facilitate electronic transfer and manipulation of data. At a minimum, procedures for intralaboratory data entry will be standardized. No-data entries will be marked with a "-" to indicate that data was not omitted. Abbreviations for technicians' names and routine laboratory observations are useful in reducing data recording and entry costs, but will be standardized whenever possible. A list of definitions will accompany data sheets and project files. Data will be recorded in indelible ink; corrections will be made by making a single line through the mistake, correcting the mistake, and dating and initialing the correction. An initialed explanation for the lined-out data will be footnoted at the bottom of the data sheet.

Standardization

Statistical analysis will be standardized. Consistency in data entry, analyses, and transfer will result in cost-effective laboratory efforts. Numerous toxological databases are in existence, but a final decision on standardized data entry, analyses, and reporting procedures has not yet been made by regulatory agencies. The criteria for standardization will be formulated as quickly as possible.

Data Validation

Each computer program establishes technically sound, documented data-validation criteria that serves to accept or reject data in a uniform and consistent manner. Data validation includes visual checks for proper identification and transmittal errors. In addition, data that do not meet

the acceptance criteria of the target reporting limits for each site will not be considered as reportable data.

Original data will be validated (100 percent) at each level of transcription (e.g., entering data from bound laboratory notebooks into computer data bases). Upper level data validation (senior scientist/program manager) will be conducted on a minimum of 10 percent of the data points. External QA/QC review will be performed on a minimum of 10 percent of the data points. In addition, daily review will be conducted on all data forms for outliers or unusual observations. Acceptable limits will be included on data forms to ensure that outliers are identified early. At the end of the toxicity test, 10 percent of the test end points will be verified by another observer. Animals placed in exposure containers will be double counted to ensure that the correct number is tested.

Archival

Data storage and archival is program specific. Backup copies of all data will be maintained at a separate location.

Data Acceptance

The criteria for accepting or rejecting analytical data depend on such factors as type of analysis, concentration found, program requirements, and sample type. Each analysis is evaluated by one or more of the following: calibration to known range of analytes, standard additions to determine matrix interference, instrument response factor, tracers, replicate analysis, control samples, or cation/anion balance.

Target Reporting Limits

Reporting limits for volatile and semi-volatile organics are listed in EPA SW-846 (Third Edition). Reporting limits for inorganic analysis will be specified in the Sampling and Analysis Plan.

Identifying and Handling Unacceptable Data and/or Outliers

Criteria for establishing outlier values are program specific. Toxocological test end point outliers are generally more important than water quality outliers. Depending upon program requirements, outliers will be accepted and identified or rejected and selectively removed. Data will be accepted and identified or rejected and selectively removed. Data will be analyzed with and without outliers. If the reason for an outlier can be explained, it will generally be removed from a data set. Outliers removed from a data set will be reported and the reasons for their removal justified.

Measurements of Precision and Accuracy

Laboratory precision for toxocological tests is concerned with the reproductability of results under a given set of conditions. Accuracy is the measurement of the bias in the measurement

system. Measurements of precision will be obtained through the use of a negative control (native sediment) and through the use of standard reference toxicants. EEI will evaluate standard reference toxicant results using a control chart and demonstrate appropriate testing procedures through acceptable negative sediment control survival.

Measurements of Completeness and Comparability

Completeness is a measure of the amount of data obtained versus the amount of data originally intended to be collected. Eighty to 90 percent data completeness will be considered acceptable. However, some studies may require a higher level of completeness to ensure confidence in data analyses results. Completeness will be measured relative to whether data can be used with 100 percent confidence to make an environmental decision. Generally, end point data (e.g., survival, growth, and reproduction) will be 100 percent complete or the statistical power of the tests may be compromised. If data completeness is less than 80 percent for a toxocological test, that test will be repeated or best professional judgment used to assess the usefulness of the data for decision-making purposes. Comparability is defined as the confidence with which one data set can be compared with another. Comparability and confidence will be enhanced through interlaboratory calibration, the consistent use of one type of reference toxicant, and the use of intralaboratory control charts to assess test organism sensitivity.

4.2 Internal Quality Control Procedures

Internal quality control procedures for analysis of the specified parameters by the laboratory will be in accordance with the work assignment requirement. The specifications will include the types of audits required (sample spikes, surrogate spikes, reference samples, controls, blanks), the frequency of each audit, the compounds to be used for sample spikes, and the quality control acceptance criteria for these audits.

Quality control procedures for field measurements are limited to checking the reproducibility of the measurement in the field by obtaining multiple readings and/or by calibrating the instruments (where appropriate). Quality control of field sampling will involve collecting field duplicates and blanks in accordance with the applicable procedures described in the Sampling Procedures discussed earlier.

Data Sheets

Data sheets, which report blank and spiked sample checks performed, will be provided and will indicate when a quality-control check was performed. The Relative Percent Difference (RPD) allowable from the reference standards and blanks will be identified for each parameter quantified on the data reports.

EEI Subcontract Laboratory

The EEI subcontractor laboratory performing analyses for this project will be required to use EPA SW-846 (Third Edition, November 1986) methodologies. In addition, EEI may, at its discretion, audit the subcontractor laboratory.

Taxonomic Verification and Test Organism Handling

Since taxonomic verification requires qualified experts (whose opinions may differ), reference toxicant response will be considered as the primary means of assessing test organism appropriateness. The source of test organisms will be documented for each toxocological test as well as the response to reference toxicants. If possible, a subsample of the test organisms will be preserved for future identification if toxocological testing information is scattered or if reference toxicant results indicate a change in sensitivity. The age of organisms used for testing will be specified in the protocols and, if possible, will be documented for each toxocological test. If age can not be determined, the mean size or biomass at testing time will be documented. test-organism loading rates will be determined by the testing protocol. Verification of loading rates via double counting will be accomplished as an internal quality control check.

Test Validation Controls and Acceptable Survival

Appropriate holding times and acclimation procedures will be specified in test protocols or SOPs and the resulting documentation made available for audit. At a minimum, laboratory seawater will be capable of supporting test organisms at a minimum of 90 percent survival for most toxocological tests. Other test validation controls may be stipulated in specific testing protocols.

Reference for Toxicant Testing

Reference toxicants will be used to assess test organism sensitivity. Results will be evaluated by developing a control chart for LC_{50} response. A variety of techniques are used to construct and evaluate control charts. If specific guidance concerning the use of control charts is not available, an acceptable reference-toxicant response will be within two standard deviations of the mean control chart response.

Monitoring for Potential Laboratory Contamination

Laboratory water will be checked annually (more often, if necessary) for trace contaminants, and this data will be made available for audit. In addition, when appropriate, test organism food and the tissues of test organisms held in culture will be analyzed periodically for the presence of trace contaminants.

4.3 Performance and Systems Audits

The performance and systems audits, which are based on the laboratory's ability to properly analyze an unknown reference sample and an on-site inspection of the facilities will be done prior to the start of each Work Assignment.

The Project Manager will monitor and audit the performance of QA/QC procedures to ensure that the project is executed in accordance with this Plan. The Project Manager will also schedule at least one systems audit of the field sampling activities to ensure that the Sampling and Analysis Plan is being adhered to and/or that variances are justified and documented.

Internal field and laboratory audits will be performed during the project to assure the quality of data derived. The audits will cover all systems and procedures identified for each work task, and will be performed during project task activities. The System Field Audit will evaluate the adequacy of the systems in place to collect and provide data of known and acceptable quality. The System Audit will be performed early in project activity. The Performance Laboratory Audit (surveillance) will be performed later in the project and will verify that the procedures identified for the tests and analyses are being implemented to provide reliable high-quality data and that the professional disciplines performing the evaluations are identified and the personnel qualified.

Personnel

Personnel assigned by the Quality Assurance Coordinator to perform the audits will be experienced quality assurance personnel and qualified technical individuals. The quality assurance personnel will lead the audits and the technical personnel (Site Manager or designated individual) will assist.

Data Assessment Procedures

Analytical data from the laboratory will be assessed for accuracy, precision, and conformance with QC criteria by the Project Manager with overview by the QC Director. The QC Director will also audit for completeness of the data packages. Data from field measurements will be assessed by thorough review of documentation that analytical procedures were adhered to, and reports from systems audits. All data will be reviewed for completeness by the Project Manager.

Quality-Assurance Audits

Quality Assurance audit activities and results will be reviewed by the Program Manager or designated individual for compliance with the quality assurance objectives for measurement of data. Whenever the Project Manager suspects or determines that the quality of the data audited is questionable, he will notify the EEI or subcontract person responsible and request a re-evaluation of the data quality. Only data confirmed as acceptable will be used in data evaluations; other data will be reported as suspect or questionable.

Quality-Control Checks

Documentation of quality-control checks performed in the field and laboratories will be reviewed by the Project Manager or designated individual to verify that they meet the requirements specified in the project specific Sampling and Analysis Plan. Samples that have not received quality-control checks at the frequency required will be identified as data of unacceptable quality and will not be used in data evaluations or hydrological mapping.

Internal Technical Review

All information resulting from this project will be subjected to an EEI internal technical review for quality of project results. Quality of data will be measured in relation to the project

requirements. The internal technical review report will be provided to the Program Manager for assessment of the quality of the data reported.

4.4 Quality Control Reports

A separate QC report will be provided for each Work Assignment. The project report will contain separate QA/QC sections summarizing the quality of data collected and/or used as appropriate to each phase of the project. The Project Manager, who has the responsibility for these summaries, will rely on written reports/memoranda documenting the data assessment. Activities nonconformance notices will be included as part of the quality assurance record.

The subcontract laboratory will be required to submit a data report that includes the individual analytical results supported by the following information to allow the data reviewer to evaluate the quality of the data:

- Sample Description (I.D. number, sample type, data sampled, date received by laboratory)
- Analytical Method(s)
- Reporting Limits
- Quality Assurance/Quality Control (QA/QC) Results, Including an Assessment of Accuracy and Precision. An example of Quality Control Checklist is provided in Figure 8.
- Name of Analyst and Reviewer

Since the sites may be on the National Priority List, a complete contract laboratory program (CLP) data report will be required. Original data worksheets, chain-of-custody records, hard copies of chromatograms or spectra, and other items normally required to be provided under the CLP will be reviewed for accuracy and completeness during a Performancy Audit of the laboratory by the EEI Quality Assurance Coordinator. Any deficiencies noted will be corrected prior to acceptance of the data.

5.0 INSTRUMENT INSPECTION, TESTING, AND CALIBRATION

5.1 Portable Flame Ionization Detector (FID) and Portable Photo Ionization Detector (PID)

Calibration methods vary depending on the instrument used and the level of confidence required. The portable organic analyzers have single calibration capabilities, which limit their use when accurate values are needed. Most analyzer methods use a single component standard at several concentrations such as methane or hexane for FID and benzene for PID analyzers. Since none of the analyzer response factors are universal for VOCs, calibration procedures using a single component do not provide accurate values for the entire range of VOC compounds. The values

QUALITY CONTROL CHECKLIST

PARAMETER

PRODUCT DATA

Project Name:
Project Number:
Client:
Client Contact:
Address:

Phone Number:

PROTOCOL

Project Testing Program
Laboratory Protocol Number
Protocol Reviewed and Signed by Client?

PROJECT STAFF

Principal Investigator
Associate Investigator
Staff
QA Officer

Protocol Reviewed by all Project Staff?

Figure 8. Quality Control Checklist

obtained will also vary greatly in keeping with the compound that is used to calibrate the analyzer.

Calibrating GCs can be more specific, and the actual method or standard used depends on the detector. For field GCs with FIDs, a single component standard such as propane or hexane can be used to calibrate the instrument. If the VOCs can be separated into carbon number class, concentration can be calculated by assuming an equal carbon response for the FID.

Only two primary gas standard are available for GC calibration, and they are the NBS propane and benzene standards. The propane standard is available in concentrations of 1 ppm, 3 ppm, 10 ppm, 50 ppm, 100 ppm, and 500 ppm. All other standards can be certified by using the NBS propane standard. These standards have been found to be very stable even at the 1 ppm level.

The PID detector is much more difficult to calibrate because the response factors vary more than those observed for the FID for each compound. To accurately quantitate samples, a response factor for each component of interest would be required. In most cases, a single compound such as benzene is used to calibrate the response. If a known mixture of organic compounds is being monitored, such as that found in a gasoline spill, the mixture can be used to calibrate the instrument and to provide a number quantitating the total amount of that mixture in a given sample. This works well if the composition at the site is homogeneous and if there are no other significant sources of the compounds in the mixture.

Once the instrument is calibrated, a quality control standard will be analyzed which comes close to approximating the expected concentration and matrix of the samples. This sample is a check to see if the calibration will accurately provide a concentration value for the components of interest. For the FID, a mixture of components is analyzed by using the single component response factor to see if it can accurately identify and quantitate the components within a set limit. This QC standard analysis provides a good indication of the day-to-day variability of the instrument.

Duplicate analyses and samples are required to determine the variability of the sampling and analytical technique. Nested duplicate samples, where samples are collected in duplicate and analyzed in duplicate, provide a means to statistically determine total variance of the method and the amount of variance which results from both the analytical method and the sampling method.

Blank analyses are required to determine the level of contamination, which results from the sampling and analytical methods. Field blanks are generated by passing a gas from a clean source through the sampling apparatus and collecting it by the method being used. This sample is sent to the lab and is analyzed as if it were a real sample. Contamination because of the analytical system is determined by injecting a volume of clean air or nitrogen into the instrument. Blanks will be run periodically and analytical system blanks run between the analysis of high-level samples and low-level samples.

Calibration of FID and PID will be performed at the start of each day of use with a standard calibration gas. Additional calibrations will be made if the unit experiences abnormal

perturbations or readings become erratic. Results of the calibrations will be recorded in a calibration log that accompanies each instrument.

During field use of the FID, a carbon filter will be used to distinguish between VOCs and methane, especially in a highly organic layer. The difference between unfiltered and carbon filtered readings is the total VOC reading.

When using the PID and FID, background air readings will be taken at regular intervals for use as background corrections for measured responses on soil samples analyzed in ambient air. Headspace samples in sealed mason jars do not require background correction.

A summary of calibration and quality control requirements for FID and PID are given in Table 4.

5.2 Field Instruments Calibration and Documentation

All field geophysical and analytical equipment will be calibrated immediately prior to use in the field. The calibration procedures will follow standard manufacturer's instructions or EEI SOPs to ensure that the equipment is functioning within tolerances established by the manufacturer and within control limits required by the project. The Field Team Leader will ensure that a copy of each instrument manual is available to the project team while in the field. A record of the instrument calibration will be maintained in the field notebook by the Field Team Leader, and these records are subject to audit by the QA/QC Manager.

The calibration frequencies listed in this section are the minimum required under ideal conditions. More frequent calibrations will be performed if readings are erratic or if the instrument experiences harsh conditions such as shock, rain, or temperature extremes. All calibrations will be recorded in the field notebook on standard field calibration forms (Figures 9, 10, and 11).

The EEI equipment manager typically performs field equipment calibration immediately prior to issuing equipment for field use. The equipment manager keeps a written record of the equipment manager's calibration for each piece of equipment calibrated for use on each particular project.

For field measurement of in situ analytical parameters, EEI typically uses a digital automatic temperature compensating multimeter (Hydrolab 4041 or Hydrolab Surveyor II). The Hyrdrolab® instruments contain sensors for temperature, pH, specific conductance, and DO in one compact sonde. The Hydrolab® uses measured temperature of the sample to automatically compensate the pH and conductivity readings for temperature-dependent variations.

Table 5 gives the field initial calibration requirements.

pH Calibration

Field calibration of pH is performed at the start of each sampling day using NIST-traceable standard buffer solutions, which bracket the pH range expected in samples. For Hydrolab® calibrations, at least two buffer standards (typically pH 4/0 and 7.0 at 25 °C) are used for

Table 4. Summary of Calibration and Quality Control Requirements for FID and PID

...e of ...rument	Detector Type	Type of Calibraton/QC Test	Frequency	Gas Standard(s)	Acceptance Criteria	Corrective Action
Portable VOC (THC) Analyezer	FID	(1) Multipoint calibration (zero plus three upscale concentrations)	At start of program	Methane or other aliphatic compound	Correlation coefficient ≥ 0.995	Repeat multipoint calibration after checking calibration dilution system
		(2) Zero (span) calibration	Daily	UHP Air or N2/Methane	Response factor agreement within ± 20% of mean RF for multipoint calibration	(1) Repeat zero span calibration (2) If still unacceptable, repeat multipoint calibration
		(3) Control sample analysis	Daily, prior to testing	Methane	Measured concentration within ± 10 % of certified concentration	(1) Repeat zero span calibration (2) Repeat control sample analysis
		(4) Drift check	Daily, at conclusion of testing	Methane	Drift value ≤ 20 % of the input value	(1) Flag day's data as questionable (2) Repair or discontinue use of analyzer
	PID	(1) Mulitpoint calibration (zero plus three upscale concentrations)	At start of program	Benzene or other aromatic compound	Correlation coefficient ≥ 0.995	Repeat multipoint calibration after checking calibration dilution system
		(2) Zero/span calibration	Daily	Benzene or other aromatic compound	Response factor agreement within ± 20 % of mean RF for multipoint calibration	(1) Repeat zero/span calibration (2) If still unacceptable, repeat multipoint calibration
		(3) Control sample analysis	Daily, prior to testing	Benzene or other aromatic compound	Measured concentration within + 10 % of certified concentration	(1) Repeat zero/span calibration (2) Repeat control sample analysis
		(4) Dirft check	Daily, at conclusion of testing	Benzene or other aromatic compound	Drift value ≤ 20 % of the input value	(1) Flag day's data as questionable (2) Repair or discontinue use of analyzer
...able Gas Chromato-graph	FID	(1) Multipoint calbration (zero plus three upscale concentrations)	At start of program	Benzene or toluene	Correlation coefficient ≥ 0.995	Repeat multipoint calibration after checking calibration dilution system
		(2) Zero/span calibration	Daily	UHP air or N2/Methane	Response factor agreement within ± 20 % of mean RF for multipoint calibration	(1) Repeat zero/span calibration (2) If still unacceptable, repeat multipoint calibration
		(3) Control sample analysis	Daily, prior to testing	Benzene	Measured concentration within ± 10 % of certified concentration	(1) Repeat zero/span calibration (2) Repeat control sample analysis
		(4) Drift check	Daily, at conclusion of testing	Benzene	Drift value ≤ 20 % of the input value	(1) Flag day's data as questionable (2) Repair or discontinue use of analyzer
		(5) Retention time checks	Daily	Benzene or toluene	None	None
		(6) Analytical blanks	Daily	UHP Air or N2	Measured concentration ≤ 5 % of the instrument span value	Clean/replace system components until acceptable blank can be obtained
		(7) Sampling system blanks	Daily, plus after very higl samples	Sample gas	Measured concentration ≤ 5 % of the instrument span value	Clean/replace system components until acceptable blank can be obtained
		(8) Duplicate samples	10 % of sampling points, minimum	Sample gas	None; provides a measure of total sampling variability	None
		(9) Control point samples	After every ten samples or once per day, whichever is greater	Sample gas	None; provides a measure of background concentration	None
		(10) Background samples	One sample per day	Sample gas	None; provides a measure of background concentration	None

Table 4. Summary of Calibration and Quality Control Requirements for FID and PID, continued

Type of rument	Detector Type	Type of Calibraton/QC Test	Frequency	Gas Standard(s)	Acceptance Criteria	Corrective Action
	PID	(1) Multipoint calibration (zero plus three upscale concentrations)	At start of program	Benzene or toluene	Correlation coefficient ≥ 0.995	Repeat multipoint calibration after checking calibration dilution system
		(2) Zero span calibration	Daily	UHP air or N2/methane	Response factor agreement within ± 20 % of mean RF for multipoint calibration	(1) Repeat zero/span calibration (2) If still unacceptable, repeat multipoint calibration
		(3) Control sample analysis	Daily, prior to testing	Benzene	Measured concentration within ± 10 % of certified concentration	(1) Repeat zero/span calibration (2) Repeat control sample analysis
		(4) Drift check	Daily, at conclusion of testing	Benzene	Drift ≤ 20 % of the input value	(1) Flag day's data as questionable (2) Repair or discontinue use of analyzer
		(5) Retention time checks	Daily	Benzene or toluene	None	None
		(6) Analytical blanks	Daily	UHP air or N2	Measured concentration ≤ 5 % of the instrument span value	Clean/replace system components until acceptable blank can be obtained
		(7) Sampling system	Daily (plus after very high samples)	Sample gas	Measured concentration ≤ 5 % of the instrument span value	Clean/replace system components until acceptable blank can be obtained
		(8) Duplicate samples	10 % of sampling points, minimum	Sample gas	None; provides a measure of total sampling variability	None
		(9) Control point samples	After every ten samples or once per day, whichever is greater	Sample gas	None; provides a measure of temporal variability	None
		(10) Background samples	One sample per day	Sample gas	None; provides a measure of background concentration	None

(Cont.)

pH Meter Calibration Form

Project: _____ Date: _____

Date: _____

			Buffer Solution					
	Time (24-hour system)	Meter Reading	7			Buffer Temp. (°C)	% Slope	Operator
Initial Calibration		Unadjusted						
		Adjusted						
		Unadjusted						
		Adjusted						
		Unadjusted						
		Adjusted						
		Unadjusted						
		Adjusted						
Intermediate Calibration		Unadjusted						
		Adjusted						
		Unadjusted						
		Adjusted						
		Unadjusted						
		Adjusted						
		Unadjusted						
		Adjusted						
Final Calibration		Unadjusted						
		Adjusted						

Intermediate checks may be made with one buffer (unadjusted reading); if readings are within 0.3 unit of the standard, no calibration adjustment is made; if greater than 0.3 unit, a complete calibration is necessary (adjusted readings); if greater than 0.2 unit, increase frequency of intermediate checks.

Signature: _____

Field Team Leader

Figure 9
pH METER CALIBRATION FORM

ENGINEERING AND ENVIRONMENT, INC

Conductivity Meter Calibration Form

Project: _____ Date: _____

Meter: _____ Standards Temp.: _____

Is meter temperature compensated? _____Yes _____No

Manual Correction to 25°C

$C_{25} = \frac{CK}{1 + .019 (t - 25)}$ where,

C = meter reading (uncompensated)
T = solution temperature (°C)
K = Cell constant = 1 (most probes)

Time _____ Signature: _____

	Standard (umhos/cm)	Meter Reading	Meter Reading @ 25°C	% Error * Std-Meter @ 25°C Std (100)
1.)				
2.)				
3.)				

Time: _____ Signature: _____

	Standard (umhos/cm)	Meter Reading	Meter Reading @ 25°C	% Error * Std-Meter @ 25°C Std (100)
1.)				
2.)				
3.)				

Time: _____ Signature: _____

	Standard (umhos/cm)	Meter Reading	Meter Reading @ 25°C	% Error * Std-Meter @ 25°C Std (100)
1.)				
2.)				
3.)				

* Should be less than 10

Signature: _____
Field Team Leader

Figure 10
CONDUCTIVITY METER CALIBRATION FORM

ENGINEERING AND ENVIRONMENT, INC.

FIELD EQUIPMENT CALIBRATION

Instrument _____

Date _____

Name _____

	Initial Reading	Adjusted Reading	End-Reading
Temperature	_____	_____	_____
Conductivity:			
High-Level Concentration _____	_____	_____	_____
Mid-Level Concentration _____	_____	_____	_____
Low-Level Concentration _____	_____	_____	_____
pH:			
7 Std.	_____	_____	_____
10 Std.	_____	_____	_____
4 Std.	_____	_____	_____
Dissolved Oxygen (DO):	_____	_____	_____

Air Temperature _____

Saturation at Air Temperature for Conditions _____

Turbidity:			
0 NTU	_____	_____	_____
20 NTU	_____	_____	_____
100 NTU	_____	_____	_____
800 NTU	_____	_____	_____

Figure 11
FIELD EQUIPMENT CALIBRATION FORM

ENGINEERING AND ENVIRONMENT, INC.

Table 5. Field Initial Calibration Requirements

Equipment	Standard Source	Standards	Acceptance/Rejection Criteria
D.O. Meter	Sat. Air Table	1	+/- 0.3 mg corrected table value
Hydrolab Water Quality Meter	NIST -Traceable Thermometer	temp 1	+/- 0.2°C
	Baxter Scientific Prod.	pH 3	+/- 0.2 pH units
	EEI, Tested against NIST- Traceable Stds	cond 3	+/- 1% FS of Range
	Sat. Air Table	DO 1	+/- 0.2 mg of corrected table value
pH Cond Meter	Baxter Scientific Prod.	pH 3	+/- 0.3 pH units
	EEI, Tested against NIST – Traceable Stds	cond 3	+/- 3% FS of Range
Surveyor II Hydrolab	NIST – Traceable Thermometer	temp 1	+/- 0.2°C
	Baxter Scientific Prod.	pH 3	+/- 0.2 pH units
	EEI, Tested against NIST – Traceable Stds	cond 3	+/- 1% FS of Range
	Sat. Air Table	DO 1	+/- 0.2 mg of corrected table value
	Ambient Pressure	Depth 1	adjust to 0.00
	EEI, Tested against NIST – Traceable Stds	cond 3	+/- 1%
Hydrolab Surveyor 3	NIST – Traceable Thermometer	temp 1	+/- 0.2°C
	Baxter Scientific Prod.	pH 3	+/- 0.2 pH units
	EEI, Tested against NIST – Traceable Stds	cond 3	+/- 1% FS of Range
	Sat. Air Table	DO 1	+/- 0.2 mg of corrected table value
	Ambient Pressure	Depth 1	adjust to 0.00
	Baxter (pH w/Quinhydrone)	ORP 2	+/- 20 mV of expected value
HNU PID	Alphagaz	2	+/- 10 ppm of calibration standard
OVM PID	Alphagaz	2	+/- 10 ppm of calibration standard
OVM PID	Alphagaz	2	+/- 10 ppm of calibration standard
Turbidity Meter	EEI, based on HACH	0, 20, 100,	+/- 2% of 0, 20, 100, NTU standard
	2100P Manual Procedures	and 800 NTU	+/- 3% of 800 NTU standard

calibration. The sonde is rinsed twice with the standard solution prior to obtaining readings by filling the sonde calibration cup half full with the standard, installing the cap, shaking for approximately 10 seconds, then pouring out the liquid and repeating this step. The first standard is then added and allowed to reach thermal equilibrium. The zero calibration control is then used to adjust the reading to correspond to the standard. The sonde is then rinsed twice with the second standard. The second standard is added, allowed to equilibrate, and the slope control is used to adjust the reading to the corresponding standard. The meter is then to be checked periodically through the day by rereading at least one standard. If the readings of the standard during checks vary more than $\pm$ 0.3 pH unit, the instrument will be recalibrated. The days-end calibration is performed the same way except that only the readings are recorded and the meter is not adjusted; therefore, meter drift due to sensor fouling during the day can be determined. If the drift in readings is significant, the sensors can be cleaned according to the operator's manual prior to recalibrating the meter the next day.

Conductivity Calibration

Calibration is performed at the start of each sampling day using potassium chloride (KCl) standard solutions prepared prior to each field trip. The analyst preparing the solutions verifies the standard solution versus a laboratory conductivity bridge. At least two standard solutions are chosen which are within the anticipated range of the samples to be measured. The Hydrolab® conductivity sensor is calibrated by the following procedure: rinse the sonde twice with the higher range standard as described for pH, and add the standard slowly to the calibration cup, ensuring that no air bubbles are trapped on the electrodes, and that the electrodes are fully covered. After allowing the sensors to reach thermal equilibrium (temperature and conductivity readings are stable), adjust the conductivity calibration or slope control until the readings matches the standard. Rinse the sonde twice with the second (low range) standard, add the standard, and allow to reach equilibrium. The reading of the second standard should be within $\pm$ 1 percent for the meter range being used on the Hydrolab®. For example, if the 0 to 2K scale is used for the second standard, the reading should be correct to within $\pm$ 20 microsiemens per centimeter (mS/cm). If not, the calibration is repeated. Periodic checks and day-end calibrations are performed at the same time and in the same way as for pH.

Temperature Calibration

The Hydrolab® temperature sensor is factory calibrated and is accurate to $\pm$ 0.2°C. No user calibration adjustment of the temperature is provided. The equipment manager checks the temperature system against an NIST thermometer as part of the prefield calibration. If the temperature sensor does not perform to the manufacturer's specifications, that unit is taken out of service and sent to the manufacturer for repair.

DO Calibration

Prior to use in the field, the equipment manager will calibrate the DO meter in the office. The equipment manager will keep a written record of the office calibration on file for each piece of equipment calibrated for project use. Field calibrations of DO meters will be accomplished by performing the air calibration method as specified by the equipment manufacturer daily, before

and after sampling. Daily calibration information will be recorded in the field logbook to monitor any instrument drift trends encountered during sampling.

Turbidity Calibration

Prior to use in the field, the equipment manager will calibrate the turbidity meter in the office in accordance with the manufacturer's calibration procedure. The equipment manager will keep a written record of the office calibration on file for each piece of equipment calibrated for project use. The turbidity meter will be calibrated using standards for 0 NTU, 20 NTU, 100 NTU, and 800 NTU.
Field calibrations will be performed daily before and after use in accordance with the manufacturer's procedure for field calibrations. Calibration QC checks will be performed for every 4 hours of use. Records of the field calibrations and QC checks will be kept in the field logbook.

The accuracy acceptance criteria for the turbidity meter is +/-2% for use with 0 NTU, 20 NTU, and the 100 NTU standards. The acceptance criteria for use with the 800 NTU standard is +/-3%.

6.0 PREVENTIVE MAINTENANCE

This section applies solely to field equipment. The specific preventive maintenance for the equipment to be used for each Work Assignment will be provided in the Sampling and Analysis Plan for that Work Assignment. The Field Manager will be responsible for implementing and documenting these procedures on a weekly basis during the period of use.

All devices and equipment used for this project will be cleaned in accordance with the decontamination procedures for field equipment. Equipment will be supplied and maintained as identified in Table 4 to perform required functions in the field and the laboratory. Manufacturer's recommendations for preventive and corrective maintenance, and instructions for decontamination and protection will be followed. Technical procedures will identify the manufacturer or recommendations and special instructions for purging and cleaning the equipment prior to, during, and after each use. Spare parts will also be available for each piece of major equipment.

Table 6. Equipment Preventive Maintenance Schedule

Manufacturer	Model	Description	Interval
RTI	1270/1271	Radon Chamber	12 Months
Bendix	ELOO47A	Crutch Scanner	6 Months
Scintex	GAD 6	Spectrometer	6 Months
Geometrics	GR410	Spectrometer	6 Months
Eberline	PRS-1	Rascal	6 Months
Tektronix	TM 503	Power Module	12 Months
Canberra	1454	Linear Gate	6 Months

Table 6. Equipment Preventive Maintenance Schedule, continued

Manufacturer	Model	Description	Interval
Reuter Stokes	RSS-111	PIC	6 Months
EDA	225	Pump	6 Months
Eberline	WLR-1	Reader	As Required
Gastech	GX86	Gas Detector	As Required
Ludlum	117-10	Ratemeter	6 Months
Berthold	LB122	Survey Meter	6 Months
Alnor	8100	Velometer	12 Months
F & J Spec. Prod.	C-814	Pressure Indicator	As Required
Specialty Products	50M010	Air-Flow Gauge	12 Months
Eberline	ESP-1	Ratemeter Scaler	6 Months
Ludlum	19	Micro-R-HR	6 Months
Ludlum	2000	Portable Scaler	6 Months
Elgin Mach. Co.	Mod-2	Modified Sampler	6 Months
Ludlum	12	Ratemeter	6 Months
MSA	G	Portable Pump	3 Months
Eberline	PRM-7	Ratemeter	6 Months
Eberline	RO-3	Ion Chamber	6 Months
Eberline	ESP-1W	Smart Portable	6 Months
RADECO	H809V1	Pump	6 Months
MSA	Flowlite	Portable Pump	3 Months

6.1 Nonconformance Reporting

A nonconformance and corrective action program will be provided to discern, identify, and correct errors and defects at any point in the project implementation process. The data-validation activities and Performance and Systems Audits may identify some of the key errors and deficiencies. Deficient data will be tallied, documentation of the results of corrective actions will be maintained, and causes will be eliminated prior to continuing work.

A nonconformance is defined as a malfunction, failure, deficiency, or deviation that renders the quality of an item as unacceptable or indeterminate. The nonconformance program pertains to all field equipment, measurements, and activities associated with the collection of data needed to fulfill project requirements. Any EEI employee can originate a Nonconformance Report (Figure 12). Use of the report should be restricted to items that make data unacceptable. Minor variations or deviations for any activity will be recorded on the Field Variance Log by the person noting the problem. The information from the Variance Report will be used during data evaluation to assess the results and validity of the data.

The Nonconformance Report will be used to document results which are out of control of established quality-control limits due to equipment malfunctions, equipment failure, operator error, or other conditions that adversely affect data quality. The originator of a Nonconformance Report will describe the findings on the form (Figure 12) and will then notify the Field Team

	Nonconformance Report	13. NCR No.: Page 1 of ____
1. Purchase Order Number:	2. Title or Subject:	3. Document No., Title, or Revision
4. Project, Program, or Activity	5. Supplier Name/Address	6. Job No. or ID No.

7. Item	8. Description of Nonconformance	14. Disposition/Justification Instructions
	9. Probable Cause of Condition	
	10. Recommended Action to Correct	
	11. Originator's Signature or Name Date	
	12. QA Coordinator Signature Date	

15. Design Document Range Required?	16. Reportable as an Event?	17. Corrective Action Required?
o Yes (Document No. _____) o No	o Yes (Report No. _____) o No	o Yes (Specify _____) o Yes (CAR No. _____) o No

APPROVALS			
18. Technical Representative Date	Signature Date	Signature Date
QA Coordinator Date	Signature Date	Signature Date

CLOSE OUT	19. _ Disposition Completed as Directed: _ Other (*Specify*): _____ *Originator or QA Coordinator*

DISTRIBUTION	20. Action Information Copies

Figure 12. Example of a Nonconformance Report

(Continuation Sheet)

INSTRUCTIONS FOR COMPLETION OF NONCONFORMANCE REPORT

A Nonconformance Report can be issued by anyone. The individual (originator) identifying the nonconforming condition will enter, or provide to have entered, the following information to complete the portion of the Nonconformance Report within the heavy border (items 1 through 11).

1. The Purchase Order Number or Contract Number of the affected item or service, if applicable.

2. A brief descriptive side or name of the affected item or activity.

3. The requirements document number, title, etc., and revision.

4. The projects, program, or activity affected by or responsible for the item or activity.

5. The supplier or subcontractor name and address (when applicable).

6. A unique identification number for items, or the job number or other reference for activities.

7. Item (line) number of the condition when more than one affects a specific item or activity.

8. Description of the nonconformance condition in a "Required" and "Is".

9. When available, enter the most probable cause of the nonconforming condition.

10. When appropriate, enter the originator's recommendation of actions to correct the specific and related conditions.

11. The originator's signature (or printed name when prepared by the QA Director) and the date..

Figure 12. Example of a Nonconformance Report, continued

Leader, Project Manager, or Quality Assurance Director. All Nonconformance Reports will be reviewed by the Quality Assurance Director, who will then provide disposition of the nonconformance. The equipment, item, or activity may be temporarily stopped while the nonconformance is being investigated. If, in the opinion of the Quality Assurance Director, the nonconformance does not significantly affect the technical quality or use of the work, the work may continue pending resolution of the nonconformance. The basis for the decisions made by the Quality Assurance Director will be documented on the Nonconformance Report.

Data generated by analytical laboratories for EEI will be monitored by the laboratory and will be reviewed by the Quality Assurance Director or the Project Manager for conformance with established QA/QC requirements. If data fall outside accepted limits, the out-of-control condition will be recorded and reported by the laboratory using their internal Standard Operating Procedures (SOPs) for nonconformance reporting. The laboratory will notify the EEI Quality Assurance Director or Project Manager of reportable nonconformances, indicate the source of the nonconformance, and report any proposed or initiated corrective action.

Preventive Maintenance

To minimize the occurrence of instrument failure and other system malfunctions, a preventive maintenance program for field and laboratory instruments is implemented. Routine maintenance is performed as needed depending on how often the instrument is used. There are some parts of the instrument that will wear out faster and therefore will require replacement more frequently than the others. These wearable or expendable parts are kept in supply and evaluated during analysis. The major instrumentation in the laboratory is covered by the manufacturer's service contracts or agreements. A PM log is maintained for each instrument. Each PM performed is recorded in the log.

The list of field instruments and their maintenance frequency are provided in Table 7.

Salinity/Conductivity/Temperature Meter and Probe

1. Preventive maintenance protocol for the Yellow Springs Instruments (YSI) meter and probe involves red lining the meter to check the condition of the batteries and electronics for loose connections and cracked leads. These are checked daily before use and are replaced as needed.
2. Probe preventive maintenance involves verification of temperature readings using a mercury thermometer and verification that the probe does not need cleaning. A fouled probed is discovered by measuring a standard on the X100 and X10 ranges, then depressing the CELL TEST button. If the meter reading falls more than 2 percent, the probe is fouled and will be cleaned. Replacement membranes will be available.

pH Meters and Combination pH Electrodes

Preventive maintenance for the pH meter and electrodes primarily involves the proper care of the electrode. Electrodes are stored in a 1:1 solution of pH = 7 buffer and DI water. The hole to add

Table 7. Preventive Maintenance – Field

Instrument	Activity	Frequency
Dissolved oxygen Meter and probe	Check battery level	Daily and replace as needed
	Check to ensure that mechanical zero is set properly	Prior to each use
	Check DO probe membrane	As needed
	Replace membrane	As needed
pH meter	Battery replacement	As needed
	Probe replacement	As needed
Conductivity	Battery replacement	As needed
	Check loose connections	Daily
	Replatinizaton	As needed
Temperature probes	Check connections	Daily
	Check against calibrated therometer	Prior to field use
Portable organic vapor detection equipment	Clean exterior after use	Daily
	Check and recharge battery	Daily
Turbidity Meter	Clean exterior after use	Daily
	Check and recharge battery	Daily and replace as needed

internal filling solution must be plugged at all times to prevent evaporation of the solution when the electrode is not in use. When the internal filling solution has dried out, the chamber will be rinsed with DI water before the filling solution is replaced. This step prevents clogging of the probe and poor (<100 percent) slope adjustments when calibrating the electrode. When slope readings are deteriorating or a low ionic strength sample gives erroneous readings, the electrode will be treated with 1N potassium hydroxide (KOH) and 1N hydrochloric acid (HCl).

The preventive maintenance frequency is as follows:

1. The instrument batteries and electronics connections and cracks are checked daily during use.
2. Spare parts such as a replacement probe and fresh buffer solutions will be available for the system at all times and replaced as needed.

Conductivity Bridge and Cell

Preventive maintenance for the Beckman conductivity bridge involves keeping the rechargeable battery fully charged. Care for the conductivity cell involves storage in DI water.

The preventive maintenance frequency is as follows:

1. The instrument batteries and probe cables are checked daily during use.
2. Replatinization of the conductivity cell is performed according to when the cell response becomes erratic, a sharp endpoint cannot be obtained, or when inspection shows that any of the platinum black has flaked off.

Dissolved Oxygen

Preventive maintenance procedures for the YSI meter involve verifying that the mechanical zero is properly set and ensuring that the batteries are fully charged to red line the instrument. The meter is shipped to the manufacturer for repair if any other problems exist. The Model 5420 BOD probe and the Model 5418 and 5419 probes are kept ready by storage in a moist atmosphere. Probe temperature readings are verified by comparison to the readings on a mercury thermometer. The DO probe membrane is replaced prior to use of the instrument in the field. The replacement of the membrane must occur at least 24 hours before use to ensure stable readings during a large number of DO analyses. Probe replacement is necessary when the probe will not calibrate properly or there are air bubbles under the membrane. Spare parts will be available for the system components most likely to experience failure.

The preventive maintenance frequency is as follows:

1. Probe membrane is checked (for deterioration) and filling solution are checked daily. Replacement is done as necessary.
2. Battery level and electronics are checked daily and replaced as necessary.

Temperature Probes

1. Check connections, cables daily.
2. Check against calibrated thermometer in the laboratory prior to field use.

Portable Organic Vapor Detection Equipment

1. Preventive maintenance of portable organic vapor detection equipment consists of cleaning the exterior of the equipment after use with a solution of mild detergent and rising with tap water (daily). Care is taken not to flood the equipment; gentle wiping of the exterior is usually sufficient. No organic solvents are to be used. Care is taken to prevent ingestion of water or foreign solid material into the inlets of these devices during use and cleaning.
2. Batteries are charged at the intervals recommended. Deep discharge of the batteries is avoided to maximize battery service life. Procedures to be followed for these preventive maintenance activities are found in the instrument manuals supplied with this equipment.

Turbidity Meters

1. Preventive maintenance of turbidity meters consists of cleaning the exterior of the equipment after use with a solution of mile detergent and rinsing with tap water (daily). Care is taken not to flood the equipment; gentle wiping of the exterior is usually sufficient. No organic solvents are to be used. Care is taken to prevent ingestion of water or foreign solid material into the inlets of these devices during use and cleaning.
2. Batteries are recharged at the intervals recommended. Deep discharge of the batteries is avoided to maximize better service life. Procedures to be followed for these preventive maintenance activities are found in the instrument manuals supplied with this equipment.

Interface Probe

The Keck Instruments, Inc. KIR Interface Probe is a portable instrument capable of accurately measuring water and hydrocarbon levels and hydrocarbon layer thickness in monitoring wells. The KIR consists of a stainless steel and Teflon* probe attached to a reel-mounted, Tefzel* coated engineer's tape. The engineer's tape comes in standard or metric graduations and is accurate to $1/100^{th}$ of a foot. The probe has a float, which detects hydrocarbon levels and a pair of stainless steel contacts for sensing conductive fluids.

The KIR has an audible buzzer signal and a visible light which are activated when the instrument reaches water or product. The KIR features an auto shutoff circuit to prevent battery discharge. This auto shutoff circuit allows the instrument 10 minutes of continuous operation before the unit shuts off.

When the Keck KIR Interface Probe is lowered down a well and contacts any fluid with a specific gravity of .60 or greater, the float will activate the visible and audible signals. If the fluid is non-conductive, the light will be red and a solid tone will sound. If the fluid is water or other conductive fluid, the conductive contacts will cause the light to turn green and the tone will

oscillate. If the probe is lowered through the water layer to a non-conductive layer (such as DNAPLS) the tone will change and the light will return to red.

The KIR is cleaned with any detergent such as Trisodium Phosphate (TSP), Alkenox, or Liquinox. If other detergents are used, care is taken to select detergents that are compatible with Teflon*, polypropylene, and stainless steel. The reel is not submerged in any liquid, but is cleaned with a damp cloth.

If the float becomes covered with silt or mud, remove the float retaining clip, slide the float off the shaft, and clean both the float and the float shaft. Replace the float so the arrow is facing the top of the probe and replace the retaining clip. The conductive contact is cleaned with detergent and a small brush.

7.0 CORRECTIVE ACTION PROCEDURES

If a quality control audit results in detection of unacceptable conditions or data, the Project Manager will be responsible for developing and initiating corrective action. The laboratory will be notified if the nonconformance is of program significance or requires special expertise not normally available to the project team. Corrective action may include:

- Reanalyzing the samples, if holding time criteria permits.
- Resampling and analyzing.
- Evaluating and amending sampling and analytical procedures.
- Accepting the data and acknowledging its level of uncertainty.

If corrective action is required to correct problems associated with variance or nonconformance items, the proposed corrective action will be approved by the Field Team Leader or Project Manager in the case of variances and by the Quality Assurance Coordinator in the case of nonconformances. The corrective action(s), once initiated, will be tracked and reviewed by the Quality Assurance Coordinator for evidence that the data or activity are within the established control limits. Failure to demonstrate that the corrective action is effective will result in work stoppage until the problem is corrected. In the case of laboratory data, the laboratory may be requested, when possible, to rerun the analyses in question until acceptable data are received.

Corrective may be required when a deficiency or deviation from planning documents or procedures is discovered or when there are deviations from established Data Quality Objectives (DQOs). Deviations from planning documents will be documented on a deviation form. An example of this form is presented in Figure 13.

7.1 Data Completeness

Data needs to be complete enough to enable decisions to be made. Minimum requirements will be set to allow for this. Although project specific, 80 to 90 percent completeness is considered acceptable. It is noted that there are different levels of importance associated with different categories of information (e.g., end point data is more important than water quality information).

ALTERATION CHECKLIST

Sample Program Identification: _____

Material to be Sampled: _____

Measurement Parameter: _____

Standard Procedure for Analysis: _____

Reference: _____

Variations from Standard Procedure: _____

Reason for Variation: _____

Resultant Change in Field Sampling Procedure: _____

Special Equipment, Material or Personnel Required: _____

Author's Name: _____ Date: _____

Approval: _____ Date: _____

Date: _____

Figure 13. Alteration Checklist (EPA/USACE 1993)

DQO Deviations

Deviations are defined as data that are outside of ranges specified in project DQOs. Out of compliance data may be due to deviations in test protocols or deficiencies associated with toxocological tests. Examples of DQO deviations in biological tests may include any of the following:

a. Excessive test organism mortality in control exposures.
b. Out of range water quality parameters.
c. Lack of randomization.
d. Lack of required reference, control, or reference toxicant exposures.
e. Out of range reference toxicant results.

Poor control survival, loss of control of exposure conditions, major mechanical errors, or mishandling of test organisms may result in a decision to retest; brief episodes of out-of-range water quality conditions, incomplete test monitoring information, or broken or misplaced test containers may only require that data be flagged and qualified.

A summary of typical test deviations and suggested corrective action is presented in Table 8.

7.2 Techniques for Corrective Action

Corrective actions relative to toxicological tests will include, but are not limited to, review of data and calculations, flagging and/or qualification of suspect data, or possible retesting. A review that provides a preliminary check of all "out of limit" events will be performed as soon as the data for a given parameter or test is tabulated and verified for accuracy. If there is any concern over the number of "out of limit" events, the EEI and District personnel will meet to decide what corrective action is required and whether retesting is necessary. All corrective actions taken will be reported on form presented in Figure 14.

7.3 Quality Assurance Reports to Management

Formal reports will be issued by the EEI Project Manager to identify progress in the execution of the planned activities. The reports include an assessment of the status of the project activities in relation to the quality and acceptance of the data. The reports will also address results of ongoing performance and system audits, data-quality assessments, and significant quality-assurance problems with proposed corrective action implementation.

8.0 FIELD INVESTIGATION PROCEDURES

This section is intended to provide guidance to the sampling team on the detailed procedures to be used for collecting samples and data in the field. Procedure descriptions are presented by media (i.e., soils, sediments, groundwater). Unusual field sampling conditions may require departures from the procedures described in this section. Such occurrences will be fully documented in the field logbooks for the affected site, and approval will be obtained before any changes are implemented. The details for the field sample-collection program, including sample

Table 8. Summary of Test Deviations and Suggested Responses		
	Suggested Response	
Deviation	Retesting Required	Retesting May Be Required
Lack of test array randomization.		4
Testing was not blind.		4
Required references or controls were not tested.	4	
Test chambers not identical.		4
Test container(s) broken or misplaced.		4
Test organism mortality in controls exceeds acceptable limits.	4	
Excessive test organism mortality in a single replicate of a control.		4
Test organisms were not randomly assigned to test chambers.		4
Test organisms were not from the same population.		4
Test organisms were not all the same species (or species complex).	4	
Test organism holding times were exceeded.		4
Water quality parameters consistently out of range.	4	
Brief episodes of out-of-range water quality parameters.		4
Test monitoring was not documented.		4
Test monitoring was incomplete.		4
Sediment holding times were exceeded.	4	
Storage storage conditions were out of acceptable ranges.		4

1 If not retested, data may have to be qualified.

2 Unless evidence is provided to show that the sediment quality (geochemistry and contaminant levels) has not been affected.

CORRECTIVE ACTIONS CHECKLIST

Sample Program Identification: _____

Sampling Dates: _____

Material to be Sampled: _____

Measurement Parameter: _____

Acceptable Data Range:

Corrective Actions Initiated By: _____

Title: _____

Date: _____

Problem Areas Requiring Corrective Action: _____

Measures to Correct Problems: _____

_____

_____

Means of Detecting Problems (Field Observations, Systems Audit, Etc.: _____

_____

_____

Approval for Corrective Actions: _____

Title: _____

Signature: _____

Date: _____

Figure 14. Corrective Action Form (U.S. EPA/ U.S. Army Corps of Engineers)

type, sample numbers, container type and size, and preservation method will be provided in Sampling and Analysis Plan. Table 9 specifies the quality assurance/quality control (QA/QC) sample types and quantities for both the field and laboratory activities.

8.1 Subsurface Soil Sampling

A truck-mounted hollow-stem auger rig will be employed to drill soil borings and to complete the subsurface soil sampling in conjunction with the drilling of groundwater monitoring wells.

With the truck-mounted auger rig centered over the sample location, a 140-pound drop hammer or equivalent hydraulic driver will be used to drive a split-spoon sampler into the desired sample interval. The hollow-stem auger will be used to auger to the sampling depth. A 2-inch O.D. by 24-inch long split-barrel sampler will be lowered to the top of the interval to be sampled. With a 140-pound drop hammer having a 30-inch drop, the sampler will be driven for the length of the sampler or until no further penetration is achieved after 50 blows for each 6 inches of penetration.

Once the sampler is full or no further penetration is possible, the sampler will be carefully removed from the borehole and separated from the drive-rod assembly. The sampler will be laid flat on an uncontaminated surface and the head and drive shoe removed. One-half of the split-spoon will be removed exposing the sample. The uppermost portion of the sample (slough) will be discarded. The interval to be collected as sample will be screened with a photoionization detector while in the split-spoon sampler. Samples to be analyzed for volatile organic compounds will be removed immediately from the core and treated as a grab sample. These samples will be collected in a manner so as to minimize disturbance of the sample. The sample will be placed into the appropriate container with no head-space, if possible, as is the practice with water samples. Samples for VOA analysis will not be mixed.

Following each sample collection, the split-spoon will be cleaned or replaced with a pre-cleaned barrel to avoid cross-contamination of the samples.

Equipment and supplies to be used in sample collecting with a split-spoon sampler include the following:

- Split-spoon Sampler (stainless steel)
- Stainless Steel Spoon
- Tape Measure
- Chain of Sample Custody Forms
- Photoionization Detector
- Disposable Latex Surgical Gloves
- Stainless Steel or Aluminum Pan
- Sample Containers
- Coolers and Ice

Table 9. Field and Laboratory Quality Assurance Sample Types and Quantities

MINIMUM FIELD QUALITY ASSURANCE								
					Minimum Laboratory Quality Assurance			
Sample Type	Analyte	Duplicates	Equipment Blanks	Trip Blanks	Checks	Duplicates	Blanks	Spikes
Groundwater	Alkalinity	10%	1/Day	2/Trip	10% 0r 1/Batch	5% 0r 1/Batch	5% 0r 1/Batch	5% 0r 1/Batch
	Common Anions	10%	1/Day	2/Trip	5% 0r 1/Batch	5% 0r 1/Batch	5% 0r 1/Batch	5% 0r 1/Batch
	Common Cations	10%	1/Day	2/Trip	5% 0r 1/Batch	5% 0r 1/Batch	5% 0r 1/Batch	5% 0r 1/Batch
	Total Dissolved Solids (TDS)	10%	1/Day	2/Trip	5% 0r 1/Batch	5% 0r 1/Batch	5% 0r 1/Batch	5% 0r 1/Batch
	Dissolved Metals	10%	1/Day	2/Trip	5% 0r 1/Batch	5% 0r 1/Batch	N/A	5% 0r 1/Batch
	Lead	10%	1/Day	2/Trip	5% 0r 1/Batch	5% 0r 1/Batch	N/A	5% 0r 1/Batch
	Purgeable Aromatics	10%	1/Day	2/Trip	5% 0r 1/Batch	5% 0r 1/Batch	5% 0r 1/Batch	5% 0r 1/Batch
Soil	Benzene, Ethylbenzene, Toluene, Xylene	10%	1/Day	2/Trip	5% 0r 1/Batch	5% 0r 1/Batch	5% 0r 1/Batch	N/A
	Lead	10%	1/Day	2/Trip	5% 0r 1/Batch	5% 0r 1/Batch	5% 0r 1/Batch	5% 0r 1/Batch

8.2 Groundwater Sampling

Groundwater will be sampled at the existing and newly installed monitoring wells. Conductivity, temperature, Eh and pH will be measured in the field at the time of sampling.

Wells will be pumped or bailed before sampling for at least three bore volumes where practical to ensure that a representative sample is being collected. The pH, temperature, and conductivity of the discharge water will be monitored during pumping. The samples will be collected after the pH, temperature, and conductivity have stabilized for at least one-half a bore volume. Purge water will be contained in drums and will be stored until analysis of the water is completed. Disposal will be based on the analytical results of the water.

The probes will be immersed in a flow-through cell soon after the pumping or bailing has begun to monitor the pH, temperature, and conductivity. The standard solutions for calibrating the pH meter will be brought to the temperature of the water in the flow-through bath, and the meter will be standardized prior to taking the pH measurements.

Electrical conductivity will be measured using a conductivity meter that has been quality checked before sampling. The conductivity probe will be placed in the flow-through bath; pH, temperature, and conductivity measurements will be recorded periodically throughout the time of pumping.

The wells will be purged using a peristaltic suction lift-type pump or Teflon bailers. This pump will also be used to collect and filter the inorganic samples. Organic samples will be collected using dedicated Teflon bailers. Wells that cannot be purged using a suction lift-type pump will be purged and sampled using a submersible bladder-type pump.

Samples requiring filtration will be filtered through a 0.45-micron membrane filter.

Sample bottles will be filled by allowing the pump or bailer discharge to flow gently down the side of the bottle with minimal entry turbulence. The sample will then be capped and stored at 4°C.

Equipment and supplies used for groundwater sampling will include the following:

- Teflon Bailers
- Conductivity Meter (temperature and conductivity)
- Eh Meter
- pH Meter
- Water-Level Indicator
- Portable Generator
- Filter Holder and Filters
- Latex Gloves
- Sample Bottles
- Concentrated HCl, Laboratory Grade
- Concentrated H_2SO_4, Laboratory Grade

- Concentrated HNO_3, Laboratory Grade
- Teflon Tubing
- Cooler with Ice (Blue Ice or equivalent)
- Maximum-Minimum Thermometer for Cooler
- Chain of Sample Custody Forms

A written record of all groundwater sampling will be developed for each sampling event.

Water-Level Measurements

An electric sounder will be used for water-level measurements at each monitoring well. The depth of water will be determined with respect to the casing top. The groundwater levels in the wells will be measured prior to sampling. The water-level measurements will be used to estimate groundwater flow directions and velocities.

Single-Well Aquifer Tests

Aquifer tests will be used to measure the hydraulic conductivity of the upper-most aquifer. Tests will be conducted on all new monitoring-well completions. The slug-withdrawal method will be used.

Aquifer Testing

The purpose of the aquifer test is to assess the hydraulic characteristics (hydraulic conductivity and transmissivity) of the shallow groundwater system within the vicinity of the site by analyzing the response to induced changes in groundwater levels. Such information will be obtained by performing slug permeability tests. The purpose of characterizing the aquifer is to acquire the necessary background information needed for the proper selection and design of potential groundwater remediation systems for the subject site.

The slug tests will be used to record the changes in the static water table in response to an instantaneous induced increase or decrease in water levels. Slug tests provide information over a short time frame and a small area of the test aquifer (i.e., the immediate vicinity of the tested well). Data from a number of slug tests that are performed in wells areally distributed across a test aquifer can be averaged to assess a greater area of the test aquifer. For this study, the water-level readings from the slug tests will be used, along with an aquifer test software package, to calculate the hydraulic characteristics needed for use in any future proposed remedial design.

Falling and rising head slug tests will be performed on all new wells. Slug tests will not be performed on wells containing free product. Slug tests will be specifically designed to record and analyze the recovery rate of a well to an instantaneously applied rise or fall in water level. The slug creates an instantaneous rise in head when lowered into the test well or a corresponding drop in head when it is withdrawn from the well. The change in head gradually increases or decreases until the water level in the well is controlled by the local transmissivity and hydraulic conductivity of the test aquifer.

Set-Up

The water level in the individual test wills will be monitored using the Hermit SE1000B data logger and a 10-psi pressure transducer. The data logger will be sent to collect data logarithmically, for the duration of each test and will seet up according to the manufacturers recommendations for the type of test being performed. The Hermit data collection schedule is logarithmic for the first 45 minutes and linear, at a rate of one data point every 10 minutes, from then on. The logarithmic collection rate used by the Hermit data logger will be as follows:

Cycle	Time Interval	Sample Frequency
1	0-2 sec	0.2 sec
2	2-20 sec	1 sec
3	20-120 sec	5 sec
4	2-10 min	0.5 min
5	10-100 min	2 min
6	100-1,000 min	10 min
7	1,000-10,000 min	100 min
8	>10,000 min	500 min

Water levels in each of the slug test wells will be measured with the automatic data logger, recorded, and then computer plotted to provide an indication of the rate of recovery of the test well.

The test slug will be consisted of gravel or sand-filled 1.5-inch diameter polyvinyl chloride (PVC) pipe sealed at both ends. The slug will be attached to a length of nylon rope to allow for lowering and raising within the test well.

Operation

For each of the slug tests, the data logger will be started and the slug will the rapidly lowered into the test well. The water levels will be recorded at a logarithmic rate to assess the changes that rapidly take place at the start of the test. At each test well the slug will be lowered to a point below the pre-test, equilibrium water-table elevation and the attached rope will be secured at the top casing (TOC) until the water level reaches a second equilibrium level. At that time, the data logger will be stepped (restarted) and the slug will then swiftly withdrawn. The subsequent water-level changes will be recorded until the water level again reaches the original equilibrium level.

The test apparatus consists of a nozzle-tipped air line connected to a compressed nitrogen-gas source (with a pressure regulator) and an electronic pressure transducer connected to an automatic electronic data logger. Both the transducer and the air line are lowered into the well. The air line and transducer cable will be marked in 1-foot increments to allow proper positioning within the well.

The transducer is lowered to a position 6 inches above the bottom of the well casing, and the cable is taped to the exterior of the casing at the top of the well. The air line is lowered until the nozzle is 6 inches above the pressure transducer. The data logger is turned on and observed until the water level in the well stabilizes (data-logger reading in constant). The recording interval is then set at "continuous," and the nitrogen regulator is turned on to inject nitrogen into the well and lift the water out of the casing.

Continuous recording is maintained for the first 5 minutes of the test. At 5 minutes, the recording interval is set to 30 seconds; at 10 minutes, the recording interval is set to 1 minutes; at 20 minutes, the recording interval is set to 2 minutes; and at 40 minutes, the recording interval is set to 5 minutes. The maximum recording interval of 10 minutes is set at 2 hours into the test and maintained until the water-level recovery rate has become negligible.

The data from the slug tests will be entered into individual data files on a microcomputer. The first column will be "time in seconds;" the second will be "hydraulic head in feet." The computer program will be used to calculate the hydraulic conductivity from the slug-test data. The program plots the log of the normalized drawdown versus time. Well completion information is entered into the data base, and the hydraulic conductivity is calculated.

Monitoring-Well Installation

All wells will be screened in the upper-most unconfined aquifer. Only hollow-stem augers will be used for drilling. The well installations will be in accordance with local, State, and Federal guidelines.

The minimum borehole diameter will be six inches O.D. The monitoring wells will be completed using 2-inch I.D. PVC screen with 0.01-inch slot size and 2-inch I.D. flush-joint threaded casing. The annular area around the screen and extending 2 feet above the screened area will be packed with washed silica well sand which shall be of a compatible size with the slotted screen. A minimum 3-foot bentonite seal will then be placed on the top of the sand pack. The remainder of the annular space around the casing will be filled by tremming bentonite slurry into the borehole.

The wells will be installed with a 5-foot screened interval extending 3 feet below the water table. A locking cover and a concrete pad will also be installed flush mounted at the surface.

A newly completed monitoring well will not be developed for at least 24 hours after the surface pad and outer protective casing are installed. The new monitoring well shall be developed until the column of water in the well is free of visible sediment, and the pH, temperature, and specific conductivity have stabilized. In most cases the above requirements can be satisfied; however, in some cases the pH, temperature, and specific conductivity stabilizes but the water remains turbid. The on-site geologist shall make the decision as to the development completion of each well. All field decisions shall be documented in the field log book.

Drill cuttings and water removed during the drilling process will be screened with an HNU photoionization detector. Any contaminated material detected will be containerized in drums for

later disposal, depending on the results of analysis of the containerized materials. Following completion, the wells will be developed by bailing out water.

Well-Location Survey

Well-location surveys will be conducted after the installation of all monitoring wells. The surveys will include elevation or "level" surveys to establish the elevation of the monitoring well collars (top of casing) and horizontal control surveys to establish horizontal space coordinates of the wells. Well-collar elevations will be measured with respect to mean sea level. Horizontal space coordinates will be measured with respect to existing well coordinates or other survey control. Standard land surveying practices will be used.

8.3 Decontamination Procedures

Soil-Sampling Equipment

All soil-sampling equipment will be decontaminated before and after sampling. A decontamination pad will be established with plastic ground cover, wash pans, and appropriate cleaning supplies. The following procedure will be used for decontamination of equipment:

1. All visible contamination will be removed with a steel brush and/or paper towels.
2. Equipment will be washed with scrub brushes and soapy water (Alconox or equivalent)
3. Equipment will be rinsed with clean potable water.
4. Equipment will then be rinsed with laboratory-grade methanol.
5. Equipment will then be rinsed with distilled or deionized water.
6. Equipment will be allowed to air dry.

All waste solvents or contaminated water will be contained and properly disposed of by the on-base group responsible for disposal of hazardous wastes.

Drilling Equipment

All drilling equipment will be cleaned with a high-pressure hot-water washer or steam cleaner prior to entry on the site. Between borings equipment will again be cleaned with hot water or steam. After hot-water or steam cleaning, all down-hole equipment will be rinsed with methanol and the deionized water followed by air drying prior to re-use of equipment. A decontamination pad for the cleaning of drilling equipment will be constructed using plastic sheeting spread over a natural or man-made depression. The decontamination pad will be designed to ensure that the decontamination fluids are impounded or containerized for later disposal based on identification of contaminants through sampling and analysis of waste materials.

Groundwater Sampling Equipment

All measurement and sampling equipment contacting groundwater will be cleaned as the equipment is removed from the well using clean rags or paper towels. Outer-surface areas will then be cleaned using soapy water, clean potable water, methanol, and deionized water, as needed.

Equipment, such as pumps and tubing, that may become contaminated internally will be cleaned by circulating soapy water through the system. This will be accomplished by placing the pump in a bucket of soapy water, followed by a clean-water rinse through the system, and finally a deionized-water rinse. Since the equipment will be used for the collection of volatile organics, a small amount of methanol will be pumped through the system prior to the deionized-water rinse. Discharge water and solvents will be containerized and stored in steel drums. Chemical analyses will be made of the materials stored in the steel drums. Those drums having hazardous contents will be disposed of by a licensed waste company under contract. Certain fluids can be allowed to evaporate and the residue handled as routine non-hazardous waste.

Biological Procedures

Biological procedures are the written protocols or instructions describing how to perform all routine measurement activities associated with toxocological testing and related QA/QC activities. These procedures will be followed to ensure the integrity and quality of data.

Standard Operating Procedures (SOPs) and Checklists

EEI will use standardized data forms and SOPs to ensure consistency of toxocological testing and reporting. EEI will provide SOPs for all routine or repetitive activities and periodically review and update as necessary.

Good Laboratory Practices

Good laboratory practices will include both blind testing to eliminate analyst bias and randomize block designs to eliminate treatment effects related to test chamber position. The completely randomized block is the simplest form of design in which treatments are allocated to the experimental units (aquaria or test jars, for instance) at random. That is, every unit has an equal chance of receiving a particular treatment. In addition, the units are processed in a random order at all subsequent stages of the experiment where this order is likely to affect the results of a test. For example, test containers that are maintained with water or light will be randomly positioned within the testing area. If all replicates from a single treatment are placed together, then it is no longer clear if treatment differences are associated with the treatment alone or with their position within the test environment. Test containers will be analyzed in a random order and in the blind (the treatment is unknown to the observer). This prevents biases associated with increased skill at taking measurements or knowledge of test treatment identity.

Testing methods will also minimize the potential of cross-contamination by volatiles, and standardized reference toxicants will be run whenever possible. Fore marine toxocological tests,

cadmium is used extensively as a reference toxicant, but poses disposal problems. Potassium Chloride (KC1) is often used in freshwater systems, as are copper and zinc. A reference toxicant will be used that can be compared with an established database.

Control charts will be used to assess whether the sensitivity of test organisms to a given reference toxicant is within a predetermined range of acceptability. A control chart is constructed by plotting successive toxicity values (for example, LC_{50}'s) for a given reference toxicant and determining the cumulative trends exhibited for this series of samples. The mean and standard deviation will be recalculated with each successive plot until the statistics stabilize. Outlier, which are values that fall outside the upper and lower limits, are readily identifiable.

Testing procedures, including acclimation test conduct, laboratory controls, statistical design, and randomization, will be provided in test protocols and will be based, in part, on project objectives. Minimum requirements for test monitoring are presented in Tables 10 and 11.

8.5 Soil Vapor (Gas) Sampling

At each soil gas sampling location, a sampling tube (pneumometer) consisting of a slotted section of 0.5-inch diameter galvanized electrical conduit, is driven with a slide hammer to a sampling depth of 4 to 4.5 ft, with the exception of those probes installed where groundwater is suspected of being near to the ground surface. These probes are installed to a depth of 2.5 to 3 ft to accommodate shallow depth to groundwater.
The soil gas sampling apparatus consists of a Teflon tube equipped with a silicon stopper, a desiccator containing a Tedlar® sampling bag, and a battery-powered vacuum pump. To collect a sample, the silicon stopper is placed in the end of the soil gas tube and a Tedlar® purge bag is connected to the opposite end of the Teflon tube within the desiccator. The vacuum pump is then started, evacuating the desiccator and drawing soil gas from the probe into the Tedlar® purge bag. The procedure is repeated twice, with the first 2 liters (L) of soil gas vented as a purge of the sampling train. To obtain a soil gas sample, the purge bag is replaced with a clean unused Tedlar® bag and the collection procedure repeated. When a soil gas sample is obtained, the valve on the sample bag is closed, capturing the soil gas. The bag is then removed from the desiccator; labeled with a sample identification number, time, and date; and transported for analysis. Upon completion of sampling, the probes are destroyed.

Prior to analyzing a sample on the GC, it is screened with a portable Photo Ionization Detector (PID) for gross contamination to avoid overloading the GC column. If gross contamination is detected during the PID screening, the sample is diluted with ultra-zero air before analysis. The GC utilizes ultra-zero air as the carrier gas for all analyses and to establish baseline response levels for the instrument.

Appropriate standards of the target analytes are prepared at several concentration ranges in Tedlar® bags from liquid concentrate and ultra-zero air. Headspace aliquots of the standards are used to determine the retention times of the target analytes in the columns. A full set of standards is run at the beginning of each day, and standards are analyzed periodically throughout the run to check calibration and monitor retention time drift.

Table 10. Suggested Monitoring Requirements for Solid Phase Tests

	Frequency of Measurements		
Parameter	Interstitial Water	Overlying Water	Extent
Dissolved Oxygen		Daily	One replicate/treatment
Temperature		Daily	At least five locations in test array
Alkalinity[1]	Beginning	Beginning/End[2]	One replicate/treatment
Hardness[1]	Beginning	Beginning/End[2]	One replicate/treatment
Conductivity[1]	Beginning	Beginning/End[2]	One replicate/treatment
Ammonia	Beginning	Beginning/End[2]	One replicate/treatment
pH	Beginning	Beginning/End[2]	One replicate/treatment
Salinity[3]	Beginning	Beginning/End[2]	One replicate/treatment
Total Sulfides	Beginning	Daily	One replicate/treatment
Flow Rates[4]	Beginning	Beginning/End[2]	One replicate/treatment

1 Freshwater test only.
2 Or prior to water exchanges during renewal tests.
3 Marine/estuarine tests only.
If applicable, measured daily.

Table 11. Suggested Monitoring Requirements for Eluriate Tests

Parameter	Frequency	Extent
Dissolved Oxygen	Daily	One replicate/concentration treatment
Temperature	Daily	At least five locations in test array
Alkalinity[1]	Beginning/End[2]	One replicate/concentration treatment
Hardness[1]	Beginning/End[2]	One replicate/concentration treatment
Conductivity[1]	Beginning/End[2]	One replicate/concentration treatment
Ammonia	Beginning/End[2]	One replicate/concentration treatment
pH	Beginning/End[2]	One replicate/concentration treatment
Salinity[3]	Daily	One replicate/concentration treatment
Total Sulfides	Beginning/End[2]	One replicate/concentration treatment

1 Freshwater test only.
2 Or prior to water exchanges during renewal tests.
3 Marine/estuarine tests only.

Checks for instrument carryover and contamination is performed periodically by running a sample of ultra-zero air in a Tedlar® bag, especially after running heavily contaminated samples. The appropriate data, including methodology, depth of probe, location of the probe, sample specific comments, and the analytical results are recorded in the field notebooks.

The results of the soil gas survey indicate the appropriate locations for the installation of groundwater monitor wells.

Figure 15 shows the soil gas sample data sheet utilized by EEI personnel.

8.6 Staff Training Requirements

The project must have data of a sufficient and known quality in order to protect human health and the environment. Obtaining data of such quality requires that the persons collecting the data use procedures that will ensure the integrity of that data. Persons collecting data are familiar with and use established sample collection procedures in order to ensure that the data collected meet the Data Quality Objectives for the phase of work at a particular site.

Sample and data collection are performed by the highly qualified and trained personnel. The Project Manager's role in the Quality Assurance process is predominantly related to determining the data quality objectives for the site or the specific phase of work that will be performed for the site, determining the number and type(s) of samples and other data that are needed to meet the data quality objectives, evaluate the data, and determine the future course of action for the site.The Project Manager is familiar with current investigative and corrective action techniques. He also understands the roles in the State Lead process and current Storage Tank Program procedures. Staff is also familiar with the standard data collection procedures and will adjust procedures as needed to meet site specific data quality objectives.

EEI will be responsible for collecting the samples and other types of data at the assigned sites. Samples and other field data collected for the State Lead Program will meet the data quality objectives specified by the Regional State Lead Project Manager. The Regional State Lead Project Manager and the EEI Project manager will discuss these objectives and determine the scope of work needed to meet these objectives. EEI requires standard sample collection procedures and field personnel collecting samples and other data to be familiar with these standard procedures. If EEI and the Regional State Lead Project Manager believe that the standard procedures should be modified for a particular site or phase of work at that site, EEI will ensure that persons collecting the data are aware of these changes.

Depending upon the scope of work, data collection at the site may involve the use of hand-held or portable field instruments. Field personnel using these instruments will be trained in their use and follow the manufacturer's instructions. EEI will provide DEQ with a list of field test equipment used and instructions for operating that equipment. Field equipment requiring calibration will be calibrated in accordance with instructions provided by the manufacturer.

Project #_____ Sample # _____
Sampled by: _____
Date Sampled:_____, 200_____ Time:_____ (AM/PM)
Sampling System (check one):

( ) Whole air-active approach
( ) Whole air-passive approach
( ) Sorbed contaminants-active approach
( ) Sorbed contaminants-passive approach
( ) Headspace or extraction approach
( ) Soil pore liquid headspace approach

Sample Type (check one):

( ) Direct field sample
( ) Field blank
( ) Travel blank
( ) Sample container blank
( ) Sample probe blank
( ) Sample replicate

Spiked?_____with_____cc of_____
Potential reaction products due to spiking: _____
System purge volume: _____Volumes purged: _____ Sample volume: _____
Sorbent Device: Installed_____(AM/PM),_____, 200_____
Recovered_____(AM/PM), _____, 200_____
Sample container type:_____ Sample container #_____
Integral analyzer: _____ Detector: _____
Analyzer response: _____ (units) _____
Surface conditions (pavement, wet, frost, etc.) _____
Sample depth: _____ Sample rate: _____
Sample horizon data-visual estimates:
Vadose zone make-up: ( ) Native soil+rock ( ) Fill ( ) Rock
Soil composition

Clay, _____%
Soil organic matter, _____%
Fine granular material, _____%
Coarse granular material, _____%
100%

Moisture content of sampling horizon (qualitative):

( ) Dry
( ) Very ( ) Damp
( ) Slightly ( ) Moist
( ) Wet

Other characteristics of the sampling horizon:

( ) Free water present ( ) Probable connection to surface macropores
( ) Free product present
( ) Contaminant odors ( ) Indurated
( ) Poor perm. to vapor ( ) Soil discoloration
( ) Near slope or vent ( ) _____

_____
Investigator Signature/Date

Figure 15. Soil Gas Sample Data Sheet

During site visits, persons collecting data in the field will record information about the site. They will be informed as to the types of information that must be recorded and the disposition of that information.

8.7 Staff Training Documentation

A record of training completed by EEI personnel is maintained in a database. A monthly report of the database is produced for management to review to determine additional training requirements of the sampling personnel and establishing a schedule for completion of the required training. Figure 16 illustrates the training database record.

Figure 16 – Training Record

Employee	Position	Training Required	Completion Date	Requested Due Date